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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
Office of Air Quality Planning and Standards
Research Triangle Park, North Carolina 27711

2 3 SEP 1983

Mr. John Weber
President
ICONCO
33379 Railroad Avenue
Union City, California 94587

Dear Mr. Weber:

The United States Environmental Protection Agency (EPA) is currently gathering information on the air pollutant asbestos and on control techniques used to control emissions of asbestos from the demolition and renovation of buildings. This information will be used to amend the existing national emission standard for the hazardous air pollutant (NESHAP) asbestos (40 CFR 61 Subpart B) in accordance with Section 112 of the Clean Air Act. In order to set standards that are cost effective and environmentally sound, we need information on the costs and techniques of asbestos removal and control that appear to be among the most effective. To use EPA and industry time efficiently, we are gathering necessary data through written requests.

This letter is to request information on the demolition of a small hotel. The information requested is itemized in Enclosure 1 to this letter. Enclosure 2 is a draft of Chapter 6 of our background information document that will be used to support decisions on any need for revising the asbestos NESHAP. This draft includes our description of a small hotel. We are aware that it is unlikely that your company has demolished a small hotel exactly like the one described. What we would like are data on a project that your company has performed within the past 5 years that most nearly fits the description of the small hotel in Section 6.1.1.2. We are also enclosing a table (Enclosure 3) showing our cost estimates for many of the model plants described in the draft of Chapter 6, including our current cost estimates for demolition of a small hotel. The data you furnish will be used to evaluate the integrity of the small hotel and other cost estimates. Although we are not requesting this, please do not hesitate to comment on or criticize any of our other descriptions of model plants or our cost estimates if you desire to do this.

We are sensitive to the amount of labor required to respond to this request, and we have tried to limit it to the data we need for developing regulations and to minimize demands on your time. We are not asking for an exhaustive search of your records and will accept your best estimates. If you want or need assistance in preparing answers to this request, please contact us. Also you may respond "not applicable" to questions that do not apply to your operations.

The authority for EPA's information gathering is included in Section 114 of the Clean Air Act (42 U.S.C. 7414). Enclosure 4 contains a summary of this authority. If you believe that disclosure of the information we request would reveal a trade secret, you should clearly identify such information as discussed in the enclosure. Any information subsequently determined to constitute a trade secret will be protected under 18 U.S.C. 1905. If no claim of confidentiality accompanies the information when it is received by EPA, it may be made available to the public by EPA without further notice (40 CFR Part 2.203, September 1, 1976). All emission data, however, will be available to the public. It will expedite the study and simplify problems if you would separate any data claimed to be confidential from the balance of the data.

EPA has contracted with Research Triangle Institute (Contract Number 68-02-3056) to obtain information pertinent to the assessment of the NESHAP for asbestos. Thus, as noted in Enclosure 5, RTI has been designated by the EPA as an authorized representative of the Agency. Therefore, RTI has the rights discussed above and in Enclosure 4. As a designated representative of the Agency, RTI is subject to the provisions of 42 U.S.C. 7414(c) respecting confidentiality of methods or processes entitled to protection as trade secrets.

Enclosure 6 summarizes Agency and Emission Standards and Engineering Division policies and procedures for handling privileged information and describes EPA contractor commitments and procedures for use of confidential materials. It is EPA's policy that compliance by an authorized representative with the requirements detailed in Enclosure 6 provides sufficient protection for the rights of submitters of privileged information.

If you have any questions regarding this request, want assistance, or are unable to provide m[illegible]th responses to the enclosed questions by October 21, 1983, please contact Mr. John Copeland at (919) 541-5601.

Sincerely yours,

Jack R. Farmer

Jack R. Farmer
Director
Emission Standards and
Engineering Division

6 Enclosures

Demolition/Renovation Questionnaire

Date mailed
Sept. 23, 1983

Identical letters sent to the following addresses:

Mr. Harold T. Hudgins President Hudgins and Company, Incorporated Atlanta, Georgia 30318	two-story department store
Mr. Mark Schwab President Cuyahoga Wrecking Corporation 210 North Ogden Street Chicago, Illinois 60607	large power generating systems
Mr. Cran Gates Vice President Wrecking Corporation of America 3700 Wheeler Avenue Alexandria, Virginia 32304	medium industrial boiler
Mr. Norman Mandell President National Wrecking Company 1231 West 42nd Street Chicago, Illinois 60609	large office building
Mr. Bill Smith President Master Clean of North Carolina, Inc. 1175 Old Salisbury Road Winston Salem, North Carolina 27107	medium school
Dr. Raymond Campion Environmental Conservation Coordinator Exxon Corporation P.O. Box 2180 Houston, Texas 77001	large refinery
Mr. Harvey Stern Vice President Cleveland Wrecking Company 702 Chester Pike Sharon Hill, Pennsylvania 19079	single family dwelling
Hugo Nue Proler Company 901 New Dock Street Terminal Island, California 90731	cargo ship

A.M. Natkin
Environmental Affairs Coord.
Exxon Corporation
1251 Avenue of the Americas
New York, NY 10020

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ENCLOSURE 1

COST QUESTIONNAIRE FOR DEMOLITION

Please answer this questionnaire as completely as possible from existing information sources. The information is necessary to provide the EPA with an accurate description of the industry. Do not hesitate to mention any difficulties you have experienced with air pollution control techniques or in other environmental areas. Please mark each response that you claim to be confidential. If there are any questions regarding the questionnaire, please contact John Copeland at (919) 541-5595.

Form A. General Data

1. Name and address of responding company ______________________________

   ____

   ____

2. Name and telephone number of person to be contacted if further detail is needed ______________________________

   ____

   ____

3. How many demolition jobs did you perform last year (1982)? __________

   What percentage of these involved asbestos removal work? __________

4. Estimate the current average hourly rate of pay (excluding fringe benefits) for a common laborer in your employment $____/hr

ENCLOSURE 1

COST QUESTIONNAIRE FOR RENOVATION

Please answer this questionnaire as completely as possible from existing information sources. The information is necessary to provide the EPA with an accurate description of the industry. Do not hesitate to mention any difficulties you have experienced with air pollution control techniques or in other environmental areas. Please mark each response that you claim to be confidential. If there are any questions regarding the questionnaire, please contact John Copeland at (919) 541-5595.

Form A. General Data

1. Name and address of responding company ________________________

____

____

2. Name and telephone number of person to be contacted if further detail is needed ________________________

____

____

3. How many renovation jobs did you perform last year (1982)? __________

What percentage of these involved asbestos removal work? __________

4. Estimate the current average hourly rate of pay (excluding fringe benefits) for a skilled asbestos control worker (or other skilled worker that removes asbestos) in your employment $ /hr

Form B. Individual Job Data Sheet

1. Location (city and state) of job.

____

____

____

2. Dates job was performed ______________________________

____

3. Estimated total value of the job including what you were paid including return from sale of scrap and other items
$______________

4. Total estimated return from sale of scrap and other items
$______________

5. Brief description of types of salvaged materials sold (such as steel scrap, plumbing fixtures, electrical motors, etc.)

____

____

____

____

6. Brief description of your part of the job including work done by subcontractors you paid ______________________________

____

____

____

____

7. Purpose of demolition (check where applicable)

a. Site clearance for planned facility ___.
If checked, brief description of planned facility ______________

____

b. Site clearance plans unknown ___

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c. Other (explain) ______________________________

____

8. Prorate and break down the value reported in Item 3 into the following components, estimating as necessary. Use NA where item is not applicable.

a.	Location and detection of asbestos	$________
b.	Removal of objects to minimize asbestos contamination	$________
c.	Exposing hidden asbestos	$________
d.	Sealing work areas to minimize asbestos contamination of other building areas during asbestos removal	$________
e.	Sealing ducts to minimize asbestos contamination	$________
f.	Exhaust ventilation to minimize asbestos contamination	$________
g.	Filtration or other cleaning of exhaust ventilation air	$________
h.	Removal of asbestos from pipes, beams, ceilings, equipment, etc., including packaging for transport away from the demolition site	$________
i.	Transport of asbestos waste to disposal site	$________
j.	Handling of asbestos waste at disposal site	$________
k.	Replacement of objects or materials removed to minimize asbestos contamination (see Item b)	$________
l.	Decontamination of areas contaminated by asbestos	$________
m.	Monitoring the effectiveness of decontamination	$________
n.	Removal of barriers, temporary exhaust ventilation systems, etc.	$________
o.	Reporting required by NESHAP	$________
p.	Reporting required by State and/or local air pollution regulations	$________

q. Protection of employees including reporting for OSHA and State or local regulations $________

r. Water pollution control $________

s. Other costs related to asbestos (specify by footnote if more than 1 percent of Item 3) $________

t. Nonasbestos-related demolition cost other than disposal of nonasbestos waste $________

u. Disposal of nonasbestos waste $________

v. Cost of construction included in job such as ceiling or carpeting replacement, etc. (specify by footnote if more than 1 percent of Item 3) $________

w. Other (specify by footnote if more than 1 percent of Item 3; profit and overhead should be prorated for items a through v) $________

x. Total (should be the same as Item 3) $________

9. Description of asbestos removal (estimates are acceptable)

a. Type of barrier for Items 8d and 8e
   Plastic ___
   Plywood ___
   Other (specify) ________

b. Type of filter for Item 8g
   Manufacturer ________
   Cleanable fabric filter ___
   Disposable filter ___

c. Type and amount of asbestos-containing material removed for Item 8. Report in terms of either (1) area and thickness, (2) volume, or (3) bulk mass.

Soft or semihard friable (removed by screwdriver, scraper, knife, etc.) ______

Hard friable (removed by chipping tool, etc.) ______

Molded insulation (banded, etc.) ______

Blankets (banded, etc.) ______

Other (describe if more than 5 percent of total) ______

d. Location and amount of asbestos-containing material for Item 8. Report in terms of either (1) area and thickness, (2) volume, or (3) mass.

Ceiling	________
Wall	________
Structural member (fireproofing, etc.)	________
Piping	________
Equipment	________
Other	________

e. Removal tools used for Item 8h (check)

Chipping tool manual	___
Chipping tool motor driven	___
Screwdriver	___
Knife	___
Scraper	___
Hammer	___
Saw	___
Other (describe)	____________________
	____________________
	____________________

f. Dust suppression techniques for Item 8h (check)

Plain water wetting	___	
Water with wetting agent	___	
Wetting agent used	___	
Name of wetting agent	____________________	
Manufacturer of wetting agent	____________________	
Asbestos waste sealed in plastic bags	Yes ___	No ___
Vacuum cleaner used	Yes ___	No ___
Other technique used (describe)	Yes ___	No ___
Asbestos waste wetted	Yes ___	No ___

g. Provide brief description of any hidden asbestos that was exposed before removal ____________________

____

10. Waste disposal data. (Estimates are acceptable. Report in units of cubic yards except as noted.)

a. Asbestos-containing waste sealed in plastic bags ______

b. Asbestos-containing waste bulk ______

c. Distance from demolition site to asbestos waste disposal site ______miles

d. Nonasbestos-containing waste ______

e. Distance from demolition site to nonasbestos waste disposal site ______ miles

f. Was same waste disposal site used for asbestos and nonasbestos waste? Yes ___ No ___

g. Average size of load of asbestos waste ______

h. Average size of load of nonasbestos waste ______

i. Was the waste hauled under contract? Yes ___ No ___

j. Did you contract for disposal? Yes ___ No ___

11. Type of nonasbestos demolition technique

Clam and ball ___
Floor by floor ___
Implosion ___
Other (describe) ______________________________

____

____

12. Other data

a. Capital equipment required in connection with the removal and disposal of asbestos. For the equipment listed below, if used, provide the following information.

Capital Equipment	Manufacturer, Model No., Rated Capacity, HP	Number Required	Capital Cost ($/unit and yr)	Expected Life (yr)	Utilization frequency (times used/yr)
Negative air pressure (exhaust ventilation) system					
Spraying equipment					
Portable HEPA[a]-filtered vacuum cleaners					
Tanks					
Pumps					
Major hand tools Buckets Shovels Scapers Other (specify) ________ ________ ________					
Air sampling equipment					
Mobile decontamination trailer for workers					
Other capital equipment (please identify)					

[a]High-efficiency particulate air.

b. Estimate of costs incurred, if any, for utilities as a result of asbestos removal activities.

	Amount used	Cost	Total utility cost
Electricity	____ kWh	____	____
Water	____ gal	____	____
Fuel (specify type)	____ gal	____	____
____________________			
Other (identify)	____	____	____
____________________			

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ENCLOSURE 2

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6. MODEL PLANTS AND REGULATORY ALTERNATIVES

This chapter describes model plants and regulatory alternatives considered by the U.S. Environmental Protection Agency (EPA) to control asbestos emissions. The model plants and regulatory alternatives were developed to serve as a basis for estimating the environmental, economic, and energy impacts of revisions to the national emission standard for asbestos. For some source categories already covered by the standard, more stringent requirements are being considered. In addition, sources not presently covered by the standard may be added. In view of the hazardous nature of asbestos, EPA is not considering making the standard less stringent.

Model plants for demolition and renovation, milling, manufacturing, and fabricating are presented in Section 6.1. Section 6.2 presents regulatory alternatives being considered for each source category.

6.1 MODEL PLANTS

Types and sizes of model plants are presented in this section. Information on emission sources (e.g., ore drying and bag opening) for specific source categories are discussed in Chapter 3. The milling, manufacturing, and fabricating model plants presented in this section do not include data on typical air pollution control equipment currently in use. These data will come from industry reports compiled by EPA under Section 8(a) authority of the Toxic Substances Control Act (TSCA). Section 8(a) data were not available when the model plants in this section were prepared. These data may be supplemented with data gathered from questionnaires sent to industry under authority of Section 114 of the Clean Air Act. Data on air pollution control equipment will be added to model plants when they become available.

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Current controls required in demolition and renovation are expressed in the discussion of baseline in Section 6.2, Regulatory Alternatives. Alternative controls to be analyzed are also presented in Section 6.2.

Model plants were developed for demolition and renovation; asbestos milling, manufacturing, and fabricating; and asbestos waste disposal. Models for encapsulation are included in the renovation models. Models were not developed for manufacturers of asbestos shotgun shell wads or spraying (currently covered by the national emission standard for hazardous air pollutants [NESHAP]) because of the low or discontinued use of asbestos in these applications. In the context of demolition and renovation,* model plants represent structures that are to be renovated or demolished and that may be subject to a proposed revision of the standard. The sizes of the model facilities and the locations of asbestos in the models are considered representative of actual structures that will be demolished or renovated. Model plants for asbestos mills, asbestos product manufacturers, and asbestos product fabricators represent emission sources and structures at the industrial site, including onsite waste disposal facilities. For waste disposal sites, model plants represent offsite landfills, which are owned and operated by someone other than the generator of asbestos waste.

With the addition of information on air pollution control equipment from Section 8(a) data and Section 114 data, the models presented in this chapter will represent a "base case" for comparing the cost, economic, energy, and environmental impacts of regulatory alternatives. Selection of model plants is based on a review of published information and discussions with demolition contractors, asbestos industry representatives, waste management facility representatives, and Federal and State Government officials responsible for enforcing NESHAP's and for asbestos removal programs.

Model demolitions and/or renovations were developed for each of the following categories:

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*Renovation includes maintenance and repair.

- Educational buildings
- Nonhousekeeping residential buildings
- Stores and mercantile and other commercial buildings
- Multiunit dwellings
- Petroleum refinery/petrochemical plants
- Electrical utilities
- Single-unit dwellings
- Ships
- Office buildings
- Hospitals and institutions

In all of these models, waste disposal is assumed to be accomplished by hauling all debris to a waste disposal site.

Model plants were developed for the following asbestos milling, manufacturing, and fabricating facilities:

- Milling
- Paper manufacturing
- Friction materials manufacturing
- Asbestos/cement (A/C) products manufacturing
- Vinyl/asbestos (V/A) floor tile manufacturing
- Asbestos-reinforced plastics manufacturing
- Coatings and sealants manufacturing
- Gaskets and packings manufacturing
- Asbestos textiles manufacturing
- Chlorine manufacturing
- Fabricating processes

Model plants also were developed for asbestos waste disposal sites.

6.1.1 <u>Demolition and Renovation</u>

6.1.1.1 <u>Educational Buildings</u>. Educational buildings house academic or technical instruction and include schools (elementary, junior high, and senior high), colleges or universities, vocational schools, libraries, and museums. Schools were selected to represent educational buildings.

Elementary schools, junior high schools, and high schools are commonly housed in low-rise buildings that may contain any or all of the following facilities:

- Classrooms (including industrial arts room and laboratories)
- Cafeteria and kitchen
- Auditorium
- Gymnasium
- Swimming pool
- Offices
- Teachers' lounge
- Boiler room
- Library

School buildings often contain nonfriable asbestos materials in ceiling tiles, floor tiles, laboratory counter tops, A/C pipes, and other materials. Friable asbestos materials were often used as a fire-protective coating on structural steel frames; as a decorative and acoustical finish on walls and ceilings; and as thermal insulation on boilers, heaters, steam pipes, and hot water pipes.

Three sizes of schools were selected as representative of schools containing asbestos material. The first school is a small, one-story school with a total floor area of 4,013 m^2 (43,200 ft^2). The second school is a medium-sized school consisting of three buildings: a two-story main building containing 9,490 m^2 (103,000 ft^2) of floor area, a one-story cafeteria 752 m^2 (8,100 ft^2) in area, and a 1,115-m^2 (117,000-ft^2) gymnasium. The third is a large school consisting of three buildings: a three-story main building containing 21,089 m^2 (227,000 ft^2) of floor area (plus a 2,044-m^2 [22,000-ft^2] basement), a one-story cafeteria containing 1,672 m^2 (18,000 ft^2) of floor area, and a one-story gymnasium containing 2,415 m^2 (26,000 ft^2) of floor area. Tables 6-1, 6-2, and 6-3 show asbestos-containing materials in the small, medium, and large schools, respectively.

Models were developed both for renovation and demolition of these school buildings. Three models were developed to represent the renovation of small, medium, and large schools (see Table 6-4). In all three school renovation models, renovation will consist of removal of the entire ceiling, which is covered with 1.3 cm (0.5 in.) of friable asbestos material. In all school renovation models, renovation will consist of scraping the friable asbestos material from the gypsum ceilings, dropping and disposing of the ceiling, replacing the ceiling, and spraying on a nonasbestos-containing material.

TABLE 6-1. ASBESTOS MATERIALS IN SMALL SCHOOL

Location of asbestos	Amount of asbestos	Type and thickness of asbestos
Boiler	9.3 m² (100 ft²)	6.4-cm (2.5-in.) trowelled-on material
Steam piping Exposed 6.4-cm (2.5-in.)	30.5 m (100 ft)	2.5-cm (1-in.) premolded insulation
Concealed 1.9-cm (0.75-in.)	457 m (1,500 ft)	2.5-cm (1-in.) premolded insulation
Hot water piping Concealed 5-cm (2-in.)	61 m (200 ft)	0.64-cm (0.25-in.) corrugated paper
Concealed 2.5-cm (1-in.)	32.5 (350 ft)	0.64-cm (0.25-in.) corrugated paper
Ceiling	4,013 m² (43,200 ft²)	1.27-cm (0.5-in.) sprayed-on material

TABLE 6-2. ASBESTOS MATERIALS IN MEDIUM SCHOOL

Location of asbestos	Amount of asbestos-containing material	Type and thickness of asbestos
<u>Main building</u>		
Boilers (2)	42 m^2 (450 ft^2)	5-cm (2-in.) premolded block
Steam piping Exposed 7.6-cm (3-in.)	20 m (65 ft)	2.5-cm (1-in.) pre-molded insulation
Concealed 5-cm (2-in.)	165 m (540 ft)	2.5-cm (1-in.) premolded insula-tion
Concealed 2.5-cm (1-in.)	549 (1,800 ft)	2.5-cm (1-in.) pre-molded insulation
Hot-water piping Concealed 5-cm (2-in.)	110 m (360 ft)	0.6-cm (0.25-in.) corrugated paper
Concealed 2.5-cm (1-in.)	14 m (45 ft)	0.6-cm (0.25-in.) corrugated paper
Structural steel 25.4-cm (10-in.) columns	488 m (1,600 ft)	6.4-cm (2.5-in.) sprayed-on material
15.2-cm (6-in.) beams	6,858 m (22,500 ft)	3.8-cm (1.5-in.) sprayed-on material
Ceiling	9,490 m^2 (103,00 ft^2)	1.3-cm (0.5-in.) sprayed-on material
<u>Cafeteria</u>		
Boiler	4 m^2 (45 ft^2)	5-cm (2-in.) pre-molded insulation
Steam piping	11 m (36 ft)	2.5-cm (1-in.) pre-molded insulation
Exposed 5-cm (2-in.) Concealed 25-cm (1-in.)	41 m (135 ft)	2.5-cm (1-in.) pre-molded insulation

TABLE 6-2. ASBESTOS MATERIALS IN MEDIUM SCHOOL (continued)

Location of asbestos	Amount of asbestos-containing material	Type and thickness of asbestos
Ceiling	752 m^2 (8,100 ft^2)	1.3-cm (0.5-in.) sprayed-on material
<u>Gymnasium</u>		
Furnace	8.4 m^2 (90 ft^2)	5-cm (2-in.) trowelled-on material
Airducts	46 m^2 (495 ft^2)	0.6-cm (0.25-in.) corrugated paper
45.7-cm (18-in.) beams	192 m (630 ft)	3.8-cm (1.5-in.) sprayed-on material
5-cm (2-in.) hot water pipe	41 m (135 ft)	0.6-cm (0.25-in.) corrugated paper

TABLE 6-3. ASBESTOS MATERIALS IN LARGE SCHOOL

Location of asbestos	Amount of asbestos	Type and thickness of asbestos
<u>Main building</u>		
Boilers (2)	93 m² (1,000 ft²)	7.6-cm (3-in.) trowelled-on material
Steam piping		
Exposed 7.6-cm (3-in.)	42.7 m (140 ft)	2.5-cm (1-in.) premolded insulation
Concealed 5-cm (2-in.)	366 m (1,200 ft)	2.5-cm (1-in.) premolded insulation
Concealed 2.5-cm (1-in.)	1,219 m (4,000 ft)	2.5-cm (1-in.) premolded insulation
Hot-water piping		
Concealed 5-cm (2-in.)	244 m (800 ft)	0.6-cm (0.25-in.) corrugated paper
Concealed 2.5-cm (1-in.)	30.5 m (100 ft)	0.6-cm (0.25-in.) corrugated paper
Structural steel		
25.4-cm (10-in.) columns	1,067 m (3,500 ft)	6.4-cm (2.5-in.) sprayed-on material
15.2-cm (6-in.) beams	15,240 m (50,000 ft)	3.8-cm (1.5-in.) sprayed-on material
Ceiling	21,089 m² (227,000 ft²)	1.3-cm (0.5-in.) sprayed-on material
<u>Cafeteria</u>		
Boiler	9.3 m² (100 ft²)	6.4-cm (2.5-in.) trowelled-on material
Steam piping		
Exposed 2-in.	24.4 m (80 ft)	2.5-cm (1-in.) premolded insulation
Concealed 1-in.	91.4 m (300 ft)	2.5 cm (1-in.) premolded insulation

(continued)

TABLE 6-3. ASBESTOS MATERIALS IN LARGE SCHOOL (continued)

Location of asbestos	Amount of asbestos	Type and thickness of asbestos
Ceiling	1,672 m^2 (18,000 ft^2)	1.3-cm (0.5-in.) sprayed-on material
<u>Gymnasium</u>		
Furnace	18.6 m^2 (200 ft^2)	6.4-cm (2.5-in.) trowelled-on material
Air ducts	102 m^2 (1,100 ft^2)	0.6-cm (0.25-in.) corrugated paper
45.7-cm (18-in.) beams	427 m (1,400 ft)	3.8-cm (1.5-in.) sprayed-on material
5-cm (2-in.) hot water pipe	91.4 m (300 ft)	0.6-cm (0.25-in.) corrugated paper

TABLE 6-4. MODEL PARAMETERS FOR SCHOOL RENOVATIONS[a]

Small school model	
Building s ze	4,013 m^2 (43,200 ft^2)
Asbestos removed	
Ceiling	51 m^3 (1,800 ft^3)
Asbestos waste generated	45 Mg (50 ton)
Medium school model	
Building size	11,408 m^2 (122,800 ft^2)
Asbestos removed	
Ceiling	131 m^3 (4,631 ft^3)
Asbestos waste generated	118 Mg (130 ton)
Large school model	
Building size	25,176 m^2 (271,000 ft^2)
Asbestos removed	
Ceiling	289 m^3 (10,208 ft^3)
Asbestos waste generated	257 Mg (284 ton)

[a]Encapsulation of the asbestos ceilings is an alternative to asbestos removal. No asbestos is removed and no asbestos waste is generated.

For each of the school renovation models, encapsulation of the asbestos-containing material is an alternative to removal and replacement of the ceiling.

Models developed for the demolition of the schools give the amount of asbestos that must be removed prior to wrecking (see Table 6-5). Demolition will be carried out with a front-end loader for the small school and by ball and clam and front-end loader for the medium school. The large school will be demolished by ball and clam.

6.1.1.2 Nonhousekeeping Residential Buildings. Nonhousekeeping residential structures refer to buildings offering multiple accommodations for long- or short-term residents and include hotels, motels, dormitories, fraternity and sorority houses, and similar facilities. Hotels are an example of nonresidential housekeeping buildings. They offer lodging and typically meals, entertainment, and various personal services to the public. Most hotels are multistory, steel-frame buildings that, in addition to lodging facilities, contain a kitchen, restaurant, and bar; ballroom or auditorium; meeting rooms; registration desk and offices; shops; and mechanical area.

Asbestos was used in the hotels for fireproofing of steel frames; for thermal insulation on boilers, steam piping, valves, and fittings; for thermal insulation of hot water piping; and for acoustical insulation on ceilings.

Two models, a small and a large hotel, were developed to represent the demolition and renovation of hotels. The first is a large, 396-room, 12-story structure and the second is a small, 96-room, 5-story structure. Both model hotels are of brick construction with steel frames.

The large hotel model is approximately 39.5 m (130 ft) high and has a floor area of 1,712 m^2 (18,432 ft^2) on each story. The hotel has a basement containing two boilers and other mechanical equipment. Table 6-6 lists the asbestos materials in the hotel. Model parameters for the demolition of the large hotel are given in Table 6-7. Demolition will be by any of three methods: implosion, ball and clam, and floor by floor.

TABLE 6-5. MODEL PARAMETERS FOR SCHOOL DEMOLITIONS

<u>Small school model</u>	
Building area	4,013 m^2 (43,200 ft^2)
Asbestos removed	
Boilers	0.6 m^3 (21 ft^3)
Ceiling	51 m^3 (1,800 ft^3)
Pipes	0.9 m^3 (30.7 ft^3)
Asbestos waste generated	46 Mg (51 ton)
<u>Medium school model</u>	
Building area	11,408 m^2 (122,800 ft^2)
Asbestos removed	
Ceiling	131 m^2 (4,629 ft^3)
Boilers and furnaces	3 m^3 (98 ft^3)
Pipes and ducts	7 m^3 (235 ft^3)
Structural steel	77 m^3 (2,724 ft^3)
Asbestos waste generated	194 Mg (214 ton)
<u>Large school model</u>	
Building area	25,176 m^2 (271,000 ft^2)
Asbestos removed	
Ceiling	289 m^3 (10,208 ft^3)
Boilers and furnaces	9 m^3 (312 ft^3)
Pipes and ducts	9 m^3 (320 ft^3)
Structural steel	523 m^3 (18,482 ft^3)
Asbestos waste generated	739 Mg (815 ton)

TABLE 6-6. ASBESTOS MATERIALS IN LARGE HOTEL

Location of asbestos	Amount of asbestos	Type and thickness of asbestos
Boilers (2)	80 m^2 (860 ft^2)	7.6-cm (3-in.) trowelled-on material
Steam piping		
Exposed 7.6-cm (3-in.)	110 m (360 ft)	2.5-cm (1-in.) premolded insulation
Concealed 5-cm (2-in.)	152 m (500 ft)	2.5-cm (1-in.) premolded insulation
Concealed 2.5-cm (1-in.)	792 m (2,600 ft)	2.5-cm (1-in.) premolded insulation
Hot-water piping		
Concealed 5-cm (2-in.)	262 m (860 ft)	2.5-cm (1-in.) premolded insulation
Concealed 2.5-cm (1-in.)	792 m (2,600 ft)	2.5-cm (1-in.) premolded insulation
Structural steel		
30.5-cm (12-in.) columns	914 m (3,000 ft)	7.6-cm (3-in.) trowelled-on material
15.2-cm (6-in.) beams	13,716 m (45,000 ft)	3.8-cm (1.5-in.) trowelled-on material
Ceiling	348 m^2 (3,750 ft^2)	2.5-cm (1-in.) sprayed-on material

TABLE 6-7. MODEL PARAMETERS FOR DEMOLITION OF LARGE HOTEL

Building area	20,549 m^2 (221,184 ft^2
Asbestos removed	
Boilers	6.1 m^3 (215 ft^3)
Pipes	9.9 m^3 (348 ft^3)
Structural steel	471 m^3 (16,625 ft^3)
Ceiling	8.7 m^3 (308 ft^3)
Asbestos waste generated	440 Mg (486 ton)

TABLE 6-8. MODEL PARAMETERS FOR RENOVATION OF LARGE HOTEL

Building area	20,549 m^2 (221,184 ft^2)
Asbestos removed	
Ceiling	9 m^3 (313 ft^3)
Pipes	1 m^3 (30 ft^3)
Asbestos waste generated	9 Mg (10 ton)

TABLE 6-9. ASBESTOS MATERIALS IN SMALL HOTEL

Location of asbestos	Amount of asbestos	Type and thickness of asbestos
Boilers	41 m^2 (440 ft^2)	7.6-cm (3-in.) trowelled-on material
Steam piping		
Exposed 3-in.	36.6 m (120 ft)	2.5-cm (1-in.) premolded insulation
Concealed 2-in.	51.8 m (170 ft)	2.5-cm (1-in.) premolded insulation
Concealed 1-in.	274 m (900 ft)	2.5-cm (1-in.) premolded insulation
Hot-water piping		
Concealed 2-in.	88.4 m (290 ft)	2.5-cm (1-in.) premolded insulation
Concealed 1-in.	274 m (900 ft)	2.5-cm (1-in.) premolded insulation
Ceiling	223 m^2 (2,400 ft^2)	2.5-cm (1-in.) sprayed-on material

Renovation of the large hotel will consist of removing the 348 m^2 (3,750 ft^2) of asbestos-containing material on ceilings, replacing that material with a nonasbestos material, and replacing the existing asbestos insulation on 110 m (360 ft) of exposed steam piping. Model parameters for the large hotel renovation are given in Table 6-8. The small hotel is approximately 18.3 m (60 ft) high. The area of the ground floor is approximately 2,694 m^2 (29,000 ft^2), and the area of floors two through five is 936 m^2 (10,080 ft^2) per floor. The hotel has a basement containing two boilers and other equipment.

The asbestos material in the small hotel is shown in Table 6-9. Model parameters for the demolition of the small hotel are given in Table 6-10. Demolition will be by either ball and clam or floor by floor.

Renovation of the small hotel will consist of replacing the 223 m^2 (2,400 ft^2) of asbestos-containing materials on ceilings and replacing the existing asbestos insulation on 36.6 m (120 ft) of exposed 7.6-cm (3-in.) steam piping. Model parameters for the small hotel renovation are given in Table 6-11.

6.1.1.3 <u>Stores, Mercantile, and Other Commercial Buildings</u>. A small grocery and a medium department store were selected to represent this class of buildings.

6.1.1.3.1 <u>Grocery</u>. Grocery stores sell staple foodstuffs, household supplies, meats, produce, and dairy products. They are typically housed in single-story buildings that may have a basement mechanical room. Asbestos was used in grocery stores as thermal insulation on heaters, boilers, and piping systems.

The model grocery is contained in a single-story brick building with a floor area of 260 m^2 (2,800 ft^2). The building has a partial basement that contains a boiler and other mechanical equipment. Table 6-12 shows asbestos materials that the grocery contains.

Models were developed to represent the demolition and renovation of a small grocery. Demolition will be carried out by a front-end loader. Table 6-13 presents model parameters for the grocery demolition. Renovation of the model grocery will consist of replacing the

TABLE 6-10. MODEL PARAMETERS FOR DEMOLITION OF SMALL HOTEL

Building area	6,440 m^2 (69,320 ft^2)
Asbestos removed	
Boilers	3.1 m^3 (110 ft^3)
Pipes	5.2 m^3 (185 ft^3)
Ceiling	5.7 m^3 (200 ft^3)
Structural steel	157 m^3 (5,542 ft^3)
Asbestos waste generated	152 Mg (168 ton)

TABLE 6-11. MODEL PARAMETERS FOR RENOVATION OF SMALL HOTEL

Building area	6,440 m^2 (69,320 ft^2)
Asbestos removed	
Ceiling	5.7 m^3 (200 ft^3)
Pipes	0.3 m^3 (10 ft^3)
Asbestos waste generated	5.4 Mg (6 ton)

TABLE 6-12. ASBESTOS MATERIALS IN SMALL GROCERY

Location of asbestos	Amount of asbestos	Type and thickness of asbestos
Boiler	9.3 m^2 (100 ft^2)	7.6-cm (3-in.) trowelled-on material
Boiler stack	3.7 m^2 (40 ft^2)	3.8-cm (1.5-in.) premolded insulation
Steam piping		
Exposed 5-cm (2-in.)	21.3 m (70 ft)	2.5-cm (1-in.) premolded insulation
Concealed 2.5-cm (1-in.)	30.5 m (100 ft)	2.5-cm (1-in.) premolded insulation
Hot water piping		
Concealed 2.5-cm (1-in.)	12.2 m (40 ft)	2.5-cm (1-in.) premolded insulation

TABLE 6-13. MODEL PARAMETERS FOR DEMOLITION OF A SMALL GROCERY

Building area	260 m^2 (2,800 ft^2)
Asbestos removed	
Boiler	0.7 m^3 (25 ft^3)
Stack	0.1 m^3 (5 ft^3)
Piping	0.3 m^3 (11 ft^3)
Asbestos waste generated	0.9 Mg (1 ton)

TABLE 6-14. MODEL PARAMETERS FOR RENOVATION OF A SMALL GROCERY

Building area	260 m^2 (2,800 ft^2)
Asbestos removed	
Boiler	0.7 m^3 (25 ft^3)
Stack	0.1 m^3 (5 ft^3)
Pipe	0.1 m^3 (3 ft^3)
Asbestos waste generated	0.8 Mg (1 ton)

asbestos insulation on the boiler, boiler stack, and exposed steam pipe with a nonasbestos insulation. Table 6-14 presents model parameters for the grocery renovation.

6.1.1.3.2 Department store. Department stores sell a wide variety of goods arranged in several departments and range in size from one- and two-story buildings to buildings of five stories or more. Asbestos materials may be found in decorative and acoustical ceiling treatments, in thermal insulation on boilers and piping, and in fire-protective coatings on structural steel.

Models were developed to represent the demolition and renovation of medium-sized department stores. The department store is contained in a two-story brick building with a reinforced concrete frame. The building also has a basement that houses a boiler and other mechanical equipment. The basement and each above-ground story have a floor area of 2,035 m^2 (21,900 ft^2). Table 6-15 shows the asbestos materials in the department store.

Demolition will be by either ball and clam or floor-by-floor demolition. Table 6-16 presents model parameters for demolition of the medium-sized department store.

Renovation of the model department store will consist of replacing the existing boiler and the thermal insulation on all exposed stream piping. All thermal insulation will be removed from the boiler before it is dismantled and removed. Table 6-17 presents model parameters for the department store renovation.

6.1.1.4 Multiunit Dwellings. A small and a medium apartment building were selected to represent multiunit dwellings. The small apartment building is a 5-family apartment building and the medium apartment is a 50-family apartment building.

The five-family apartment building is a low-rise structure of wood frame construction. It is a three-story structure with a partial basement. Each story has a floor area of 232 m^2 (2,500 ft^2), and the basement has a floor area of 69.7 m^2 (750 ft^2). A boiler is located in the basement. Asbestos was used as decorative and acoustical

TABLE 6-15. ASBESTOS MATERIALS IN MEDIUM DEPARTMENT STORE

Location of asbestos	Amount of asbestos	Type and thickness of asbestos
Boiler	9.3 m^2 (100 ft^2)	7.6-cm (3-in.) trowelled-on material
Stack	5.6 m^2 (60 ft^2)	3.8-cm (1.5-in.) trowelled-on material
Steam piping		
Exposed 5-cm (2-in.)	57.9 m (190 ft)	5-cm (2-in.) premolded insulation
Concealed 2.5-cm (1-in.)	183 m (600 ft)	5-cm (2-in.) premolded material

TABLE 6-16. MODEL PARAMETERS FOR DEMOLITION OF A MEDIUM DEPARTMENT STORE

Building area	6,104 m^2 (65,700 ft^2)
Asbestos removed	
Boiler	0.7 m^3 (25 ft^3)
Stack	0.2 m^3 (7.5 ft^3)
Piping	1.0 m^3 (36 ft^3)
Asbestos waste generated	1.8 Mg (2 ton)

TABLE 6-17. MODEL PARAMETERS FOR RENOVATION OF A MEDIUM DEPARTMENT STORE

Building area	6,104 m^2 (65,700 ft^2)
Asbestos removed	
Boiler	0.7 m^3 (25 ft^3)
Piping	0.3 m^3 (10.6 ft^3)
Asbestos waste generated	0.9 Mg (1 ton)

TABLE 6-18. ASBESTOS MATERIALS IN SMALL, FIVE-FAMILY APARTMENT BUILDING

Location of asbestos	Amount of asbestos	Type and thickness of asbestos
Boiler	7.9 m^2 (85 ft^2)	5-cm (2-in.) trowelled-on material
Stack	4.6 m^2 (50 ft^2)	5-cm (2-in.) trowelled-on material
Steam piping		
Exposed 5-cm (2-in.)	42.7 m (140 ft)	5-cm (2-in.) premolded insulation
Concealed 2.5-cm (1-in.)	64 m (210 ft)	5-cm (2-in.) premolded insulation
Ceiling	697 m^2 (7,500 ft^2)	0.6-cm (0.25-in.) sprayed-on material

TABLE 6-19. MODEL PARAMETERS FOR DEMOLITION OF SMALL, FIVE-FAMILY APARTMENT BUILDING

Building area	766 m^2 (8,250 ft^2)
Asbestos removed	
Boiler	0.4 m^3 (14.2 ft^3)
Stack	0.2 m^3 (8.3 ft^3)
Piping	0.5 m^3 (16.6 ft^3)
Ceiling	4.4 m^3 (156 ft^3)
Asbestos waste generated	4.9 Mg (5.4 ton)

ceiling treatments and as thermal insulation on boilers and steam piping. Table 6-18 shows the asbestos material in the small apartment building.

Models were developed to represent both the demolition and renovation of a five-family apartment building. The apartment model is to be demolished by either of two methods: ball and clam or floor by floor. All asbestos materials must be removed prior to demolition. Table 6-19 gives model parameters for the demolition of the small apartment building. In the renovation model, the decorative ceiling coating is to be replaced for the entire building. Table 6-20 presents model parameters for renovation of the small apartment building.

The 50-family apartment building is a 10-story building of steel frame construction. The building has a basement housing the heating system and other equipment. Each story has a floor area of 464.5 m^2 (5,000 ft^2). Asbestos was used as decorative and acoustical ceiling treatments, thermal insulation on boilers and steam piping, and fireproofing on steel columns and beams. Table 6-21 shows the asbestos material in the 50-family apartment building.

Models were developed for the demolition and renovation of the medium apartment building. The apartment building will be demolished by implosion, ball and clam, or floor by floor. Table 6-22 gives model parameters for demolition of the apartment building. For the renovation model, the asbestos ceiling covering will be removed and replaced with nonasbestos materials. Table 6-23 presents model parameters for renovating the medium apartment building.

6.1.1.5 Petroleum Refinery/Petrochemical Plant. Petroleum refineries were selected to represent this class of structure. Refineries separate and convert crude oil and intermediates to produce a variety of fuels, lubricants, asphalts, road oils, and feedstock for other processors; e.g., the petrochemical industry. Asbestos was used extensively as thermal insulation on equipment and pipes to help maintain high-process temperatures and high-fluid temperatures in piping.

TABLE 6-20. MODEL PARAMETERS FOR RENOVATION OF SMALL, FIVE-FAMILY APARTMENT BUILDING

Building area	766 m^2 (8,250 ft^2)
Asbestos removed	
Ceiling	4.4 m^3 (156 ft^3)
Asbestos waste generated	3.9 Mg (4.3 ton)

TABLE 6-21. ASBESTOS MATERIALS IN MEDIUM, 50-FAMILY APARTMENT BUILDING

Location of asbestos	Amount of asbestos	Type and thickness of asbestos
Boiler	52.7 m^2 (567 ft^2)	5-cm (2-in.) sprayed-on material
Stack	15.8 m^2 (170 ft^2)	5-cm (2-in.) sprayed-on material
Steam piping		
Exposed 5-cm (2-in.)	85.3 m (280 ft)	5-cm (2-in.) premolded insulation
Concealed 2.5-cm (1-in.)	426.7 m (1,400 ft)	5-cm (2-in.) premolded insulation
Ceiling	4,645 m^2 (50,000 ft^2)	0.6-cm (0.25-cm) sprayed-on material
Structural steel		
30.5-cm (12-in.) columns	670.6 m (2,200 ft)	7.6-cm (3-in.) sprayed-on material
15.2-cm (6-in.) beams	2,159.2 m (7,084 ft)	3.8-cm (1.5-in.) sprayed-on material

TABLE 6-22. MODEL PARAMETERS FOR DEMOLITION OF MEDIUM, 50-FAMILY APARTMENT BUILDING

Building area	4,645 m^2 (50,000 ft^2)
Asbestos removed	
Boiler	2.7 m^3 (94.5 ft^3)
Stack	0.8 m^3 (28.3 ft^3)
Piping	2.4 m^3 (85.5 ft^3)
Ceiling	29.5 m^3 (1,041 ft^3)
Structural steel	130.8 m^3 (4,622 ft^3)
Asbestos waste generated	148 Mg (163 ton)

TABLE 6-23. MODEL PARAMETERS FOR RENOVATION OF MEDIUM, 50-FAMILY APARTMENT BUILDING

Building area	4,645 m^2 (50,000 ft^2)
Asbestos removed	
Ceiling	29.5 m^3 (1,041.7 ft^3)
Asbestos waste generated	26.2 Mg (28.9 ton)

TABLE 6-24. ASBESTOS MATERIALS IN SMALL REFINERY

Location of asbestos	Amount of asbestos	Type and thickness of asbestos
Boilers (29)	409 m^2 (4,400 ft^2) (each)	7.6-cm (3-in.) trowelled-on material
Tanks and vessels (60)	186 m^2 (2,000 ft^2) (each)	7.6-cm (3-in.) premolded material
Pumps (19)	1.7 m^2 (18 ft^2) (each)	5-cm (2-in.) premolded insulation
10-cm (4-in.) piping	109,728 m (360,000 ft)	5-cm (2-in.) premolded insulation

Models were developed to represent the demolition and renovation of small- and intermediate-capacity refineries.

The small-capacity refinery processes approximately 50,000 barrels of crude oil per day. Refinery processes include the following:

- Atmospheric and vacuum distillation of crude
- Fluid catalytic cracking
- HF alkylation/gasoline sweetening
- Gas concentration/sulfur recovery
- Gasoline fractionation
- Aromatics extraction
- Catalytic reforming.

The refinery has 186 pumps and 17 compressors in hydrocarbon service and 29 process heaters and boilers. It has 70 process vessels, 50 storage tanks, and about 900,000 feet of piping. Asbestos materials in the small refinery are shown in Table 6-24; 10 percent of the pumps, 50 percent of the tanks and vessels, and 40 percent of the piping are insulated with asbestos material.

The intermediate-capacity refinery processes approximately 200,000 barrels of crude oil per day and consists of the following processes:

- Atmospheric and vacuum distillation of crude
- Solvent decarbonizing
- Sourwater oxidizing
- Aromatics extraction
- Thermal hydrodealkylation
- Naphtha desulfurizing
- Catalytic cracking
- Acid-gas treating
- Sulfur recovery
- Gasoline sweetening
- Fractionating
- Hydrogen manufacturing
- Alkylation
- Naphtha hydrotreating
- Catalytic reforming.

This refinery has 411 pumps and 37 compressors in hydrocarbon service and 49 process heaters and boilers. It has 290 process vessels, 200 storage tanks, and approximately 3,500,000 feet of piping. The intermediate-capacity refinery contains asbestos materials as shown in Table 6-25; 10 percent of the pumps, 50 percent of the tanks and

TABLE 6-25. ASBESTOS MATERIALS IN MEDIUM REFINERY

Location of asbestos	Amount of asbestos	Type and thickness of asbestos
Boilers (49)	409 m^2 (4,400 ft^2) (each)	7.6-cm (3-in.) trowelled-on material
Tanks and vessels (245)	186 m^2 (2,000 ft^2) (each)	7.6-cm (3-in.) premolded insulation
Pumps (41)	1.7 m^2 (18 ft^2) (each)	5-cm (2-in.) premolded insulation
10-cm (4-in.) piping	426,720 m (1,400,000 ft)	5-cm (2-in.) premolded insulation

TABLE 6-26. MODEL PARAMETERS FOR REFINERY DEMOLITION

Small refinery	
Asbestos removed	
Boilers	903 m^3 (31,900 ft^3)
Tanks and vessels	850 m^3 (30,000 ft^3)
Pumps	1.6 m^3 (57 ft^3)
Piping	2,669 m^3 (94,250 ft^3)
Asbestos waste generated	1,968 Mg (2,170 ton)
Medium refinery	
Asbestos removed	
Boilers	1,526 m^3 (53,900 ft^3)
Tanks and vessels	3,469 m^3 (122,500 ft^3)
Pumps	358 m^3 (123 ft^3)
Piping	10,379 m^3 (366,528 ft^3)
Asbestos waste generated	6,842 Mg (7,542 ton)

TABLE 6-27. MODEL PARAMETERS FOR REFINERY MAINTENANCE

Small refinery	
Asbestos removed	
Pipes	7.4 m^3 (262 ft^3)
Asbestos waste generated	0.6 Mg (7.3 ton)
Medium refinery	
Asbestos removed	
Pipes	7.4 m^3 (262 ft^3)
Asbestos waste generated	6.6 Mg (7.3 ton)

vessels, and 40 percent of the piping are insulated with asbestos material.

Each of the refinery models is to be totally demolished by disassembly. All asbestos materials must be removed and disposed of during demolition. Table 6-26 presents model parameters for the refinery demolitions.

Each model refinery also will conduct maintenance (renovation) activities that involve asbestos removal. In both the small and medium refinery, maintenance will consist of removing 457 m (1,500 ft) of 10-cm (4-in.) diameter steam piping located above ground. Table 6-27 presents model parameters for the maintenance activities.

6.1.1.6 Electric Utilities. Steam-electric-generating plants often used asbestos materials as thermal insulation in fossil-fuel-fired watertube boilers and associated turbines, valves, fittings, and piping.

Models were developed to represent the demolition and renovation (maintenance) of small and medium power plants. The first model is a small, 12-MW power station. Asbestos materials in the small power plant are listed in Table 6-28. The medium power plant is a 200-MW plant and contains asbestos material as shown in Table 6-29. Complete demolition of the two power plants is to be carried out by disassembling the unit. Model parameters for the power plant demolitions are given in Tables 6-30 and 6-31.

Renovation (maintenance) will consist of the overhaul of the turbines and associated piping at each plant. Model parameters for the power plant maintenance activities are given in Tables 6-32 and 6-33.

6.1.1.7 Industrial Buildings. Industrial buildings house manufacturing and the processing or procurement of goods, merchandise, raw materials, or food. Boilers are an important part of many industrial operations. Because of the prevalence of boilers in industrial plants and because thermal insulation is used on boilers and their associated steam and hot water piping, model boilers were developed to represent the occurrence of asbestos in industrial buildings.

TABLE 6-28. ASBESTOS MATERIAL IN SMALL, 12-MW POWER PLANT

Location of asbestos	Amount of asbestos	Type and thickness of asbestos
Boiler	74 m^2 (800 ft^2)	7.6-cm (3-in.) premolded insulation
Turbine	3 m^2 (30 ft^2)	7.6-cm (3-in.) premolded insulation
Pipes	457 m (1,500 ft)	7.6-cm (3-in.) premolded insulation
Miscellaneous	19 m^2 (200 ft^2)	7.6-cm (3-in.) premolded insulation

TABLE 6-29. ASBESTOS MATERIALS IN MEDIUM, 200-MW POWER PLANT

Location of asbestos	Amount of asbestos	Type and thickness of asbestos
Boiler	1,189 m^2 (12,800 ft^2)	7.6-cm (3-in.) premolded insulation
Turbine	18.6 m^2 (200 ft^2)	7.6-cm (3-in.) premolded insulation
Pipes	6,096 m (20,000 ft)	7.6-cm (3-in.) premolded insulation
Miscellaneous	232 m^2 (2,500 ft^2)	7.6-cm (3-in.) premolded insulation

TABLE 6-30. MODEL PARAMETERS FOR SMALL, 12-MW POWER PLANT DEMOLITION

Asbestos removed	
Boile	5.7 m^3 (200 ft^3)
Turbine	0.2 m^3 (8 ft^3)
Pipes	10.6 m^3 (375 ft^3)
Miscellaneous	1.4 (50 ft^3)
Asbestos waste generated	16 Mg (18 ton)

TABLE 6-31. MODEL PARAMETERS FOR MEDIUM, 200-MW POWER PLANT DEMOLTION

Asbestos removed	
Boiler	91 m^3 (3,200 ft^3)
Turbine	1.4 m^3 (50 ft^3)
Pipes	555 m^3 (19,600 ft^3)
Miscellaneous	18 m^3 (625 ft^3)
Asbestos waste generated	296 Mg (326 ton)

TABLE 6-32. MODEL PARMETERS FOR SMALL, 12-MW POWER PLANT MAINTENANCE

Asbestos removed	
Turbine	0.2 m^3 (8 ft^3)
Pipes	1.1 m^3 (38 ft^3)
Asbestos waste generated	1.2 Mg (1.3 ton)

TABLE 6-33. MODEL PARAMETERS FOR MEDIUM, 200-MW POWER PLANT MAINTENANCE

Asbestos removed	
Turbine	1.4 m^3 (50 ft^3)
Pipes	56.2 m^3 (1,990 ft^3)
Asbestos waste generated	51 Mg (57 ton)

Models were developed to represent maintainance and demolition of a small and medium boiler in a small and medium industrial building, respectively. Boiler demolition is done in the context of demolition of the industrial building. Asbestos materials in the small and medium industrial buildings are shown in Tables 6-34 and 6-35, respectively.

Demolition of the boilers is to be carried out by dismantling and removing the boiler. All asbestos materials must be removed from the boiler, pipe, and exhaust duct before they are dismantled and removed. Table 6-36 presents model parameters for the boiler demolitions.

For the renovation or maintenance models, the boilers will be repaired, which will involve removal of asbestos on boilers, boiler stacks, and a small amount of steam piping. The asbestos on most of the steam piping is not affected. Table 6-37 presents model parameters for the boiler maintenance/repair work.

6.1.1.8 Single-Unit Dwellings. Single-unit dwellings provide basic living accommodations for a family. These dwellings normally contain cooking and dining facilities, sleeping quarters, and areas for leisure and recreational activities. They are mostly one- or two-story wood frame structures and often have a partial basement furnace room.

Asbestos has been used for a wide variety of applications in private home constructions. Some applications have been common, while others have been only occasional. The following list summarizes asbestos use in private homes:

- Furnace and pipe insulation.
- Floor coverings (V/A floor tile and paper backing for other floor coverings).
- Roofing products (asphalt shingles, A/C shingles, and roofing felts).
- Siding materials (A/C shingles).
- Tape joint and spackling compounds.

TABLE 6-34. ASBESTOS MATERIALS IN SMALL INDUSTRIAL BUILDING

Location of asbestos	Amount of asbestos	Type and thickness of asbestos
Boiler	139 m^2 (1,500 ft^2)	6.4-cm (2.5-in.) layered paper and trowelled-on material
15-cm (6-in.) steam pipe	152 m (500 ft)	3-cm (1.2-in.) premolded insulation
Boiler exhaust duct	19.9 m^2 (214 ft^2)	1.3-cm (0.5-in.) trowelled-on material

TABLE 6-35. ASBESTOS MATERIALS IN MEDIUM INDUSTRIAL BUILDING

Location of asbestos	Amount of asbestos	Type and thickness of asbestos
Boiler	929 m^2 (10,000 ft^2)	6.4-cm (2.5-in.) layered paper and trowelled-on material
30.5-cm (12-in.) steam pipe	456 m (1,500 ft)	3-cm (1.2-in.) premolded insulation
Boiler exhaust duct	63.2 m^2 (680 ft^2)	1.3-cm (0.5-in.) trowelled-on material

TABLE 6-36. MODEL PARAMETERS FOR INDUSTRIAL BUILDING BOILER DEMOLITION

Small industrial boiler	
Asbestos removed	
Boiler	8.8 m^3 (312 ft^3)
Pipe	2.2 m^3 (78.5 ft^3)
Exhaust duct	0.3 m^3 (8.9 ft^3)
Asbestos waste generated	10.1 Mg (11.1 ton)
Medium industrial boiler	
Asbestos removed	
Boiler	59 m^3 (2,083 ft^3)
Pipe	13.3 m^3 (471.2 ft^3)
Exhaust duct	0.8 m^3 (28.3 ft^3)
Asbestos waste generated	65.1 Mg (71.7 ton)

TABLE 6-37. MODEL PARAMETERS FOR INDUSTRIAL BUILDING BOILER MAINTENANCE

Small industrial boiler	
Asbestos removed	
Boiler	8.8 m^3 (312 ft^3)
Pipe	0.1 m^3 (1.9 ft^3)
Exhaust duct	0.3 m^3 (8.9 ft^3)
Asbestos waste generated	4 Mg (4.5 ton)
Medium industrial boiler	
Asbestos removed	
Boiler	59 m^3 (2,083 ft^3)
Pipe	0.2 m^3 (6.9 ft^3)
Exhaust duct	0.8 m^3 (28.3 ft^3)
Asbestos waste generated	26 Mg (29 ton)

- Wallboard (used for fireproofing between living area and attached garages).
- Textured ceiling paint.
- Ceiling tile.
- Wall and ceiling insulation.

Furnace and pipe insulation, tape joint and spackling compounds, A/C shingles, and textured ceiling paint were used widely in home construction and are considered friable materials. Floor coverings and asphalt roofing products also were used frequently but are not considered friable because the asbestos is bound tightly in the products and would not be released significantly during demolition. Asbestos-containing wallboard, ceiling tile, and wall and ceiling insulation were used infrequently in private home construction. All are considered friable.

Three models of single-unit dwellings were selected as representative of the class. All three have the same structure but differ in the extent to which asbestos-containing products were used in their construction. The structure for each model is a one-story wood frame building with a floor area of 120 m^2 (1,288 ft^2), a partial basement with a floor area of 20 m^2 (216 ft^2), and an attached garage with a floor area of 10.8 m^2 (116 ft^2). The quantities of asbestos products in each model are shown in Table 6-38.

Demolition of each model is to be accomplished with a bulldozer. Model parameters for the private home demolitions are presented in Table 6-39.

Renovation of each model will involve removal of different quantities of asbestos. In Model A, the asbestos insulation on the furnace is to be replaced with a nonasbestos insulation. In Model B, the asbestos furnace insulation is to be replaced and the asbestos-covered ducts are to be removed and replaced with a nonasbestos-covered ductwork. The asbestos-covered ceiling in Model C will be replaced. Model parameters for the private home renovations are presented in Table 6-40.

TABLE 6-38. ASBESTOS MATERIALS IN SINGLE-UNIT DWELLING

Location of asbestos	Amount of asbestos	Type and thickness of asbestos
<u>Model A</u>		
Furnace	6.7 m^2 (72 ft^2)	7.6-cm (3-in.) trowelled-on material
12.7-cm (5-in.) ducts	18.3 m (60 ft)	5-cm (2-in.) premolded insulation
<u>Model B</u>		
Furnace	6.7 m^2 (72 ft^2)	7.6-cm (3-in.) trowelled-on material
12.7-cm (5-in.) ducts	18.3 m (60 ft)	5-cm (2-in.) premolded insulation
Walls (interior)	10.4 m^2 (112 ft^2)	1.6-cm (0.6-in.) wallboard
<u>Model C</u>		
Furnace	6.7 (72 ft^2)	7.6-cm (3-in.) trowelled-on material
12.7-cm (5-in.) ducts	18.3 m (60 ft)	5-cm (2-in.) premolded insulation
Walls (exterior)	110 m^2 (1,184 ft^2)	0.6-cm (0.3-in.) A/C shingles
Ceiling	120 m^2 (1,288 ft^2)	1.3-cm (0.5-in.) sprayed-on material

TABLE 6-39. MODEL PARAMETERS FOR DEMOLITION OF SINGLE-UNIT DWELLINGS

Model A	
Asbestos removed	
Furnace	0.5 m^3 (18 ft^3)
Ducts	0.5 m^3 (18 ft^3)
Asbestos waste generated	0.9 Mg (1 ton)
Model B	
Asbestos removed	
Furnace	0.5 m^3 (18 ft^3)
Ducts	0.5 m^3 (18 ft^3)
Walls	0.2 m^3 (6 ft^3)
Asbestos waste generated	1.1 Mg (1.2 ton)
Model C	
Asbestos removed	
Furnace	0.5 m^3 (18 ft^3)
Ducts	0.5 m^3 (18 ft^3)
Exterior walls	0.7 m^3 (25 ft^3)
Ceiling	1.2 m^3 (54 ft^3)
Asbestos waste generated	2.9 Mg (3 ton)

TABLE 6-40. MODEL PARAMETERS FOR RENOVATION OF SINGLE-UNIT DWELLINGS

Model A	
Asbestos removed	
Furnace	0.5 m^3 (18 ft^3)
Asbestos waste generated	0.5 Mg (0.5 ton)
Model B	
Asbestos removed	
Furnace	0.5 m^3 (18 ft^3)
Ducts	0.5 m^3 (18 ft^3)
Asbestos waste generated	0.9 Mg (1 ton)
Model C	
Asbestos removed	
Ceiling	1.2 m^3 (54 ft^3)
Asbestos waste generated	1.4 Mg (1.5 ton)

6.1.1.9 Ships.

6.1.1.9.1 Passenger ships. Passenger ships are large vessels normally driven by steam power. They are equipped with boilers, turbines, and associated piping and equipment that require thermal insulation.

Asbestos insulation is located on steam and hot water pipes and fittings, feedwater pumps, evaporators, turbines, and condensers.

One model was developed to represent a maintenance activity on a cruise ship. Maintenance consists of the overhaul of two turbines on a 22,680-Mg (25,000-ton) cruise ship. Overhaul requires removal of asbestos insulation from turbines and related pipes, valves, and fittings. Table 6-41 shows the quantities of asbestos involved, and Table 6-42 presents model parameters for the turbine overhaul.

6.1.1.9.2 Cargo ships. Cargo ships are of many different types and classes, depending on the type of service for which they were designed. They range in length from about 152 m (500 ft) to more than 305 m (1,000 ft). When ships are retired from active service, they are placed in a reserve fleet where, from time to time, they are designated for scrap and put up for bids.

Asbestos-containing products on cargo ships consist of wallboard to cover the bulkheads in the accommodations area and of insulation on hot water and steam piping and on boilers, tanks, and machinery casings.

One model was selected to represent demolition of an average-sized cargo ship. The model cargo ship has a length of 152 m (500 ft), a beam of 18.3 m (60 ft), and a deadweight of about 9,072 Mg (10,000 ton). The model ship will be demolished by a ship-wrecking crew, who will remove all asbestos-containing material before dismantling the ship. Table 6-43 shows the quantities of asbestos materials the model cargo ship contains. Model parameters for the cargo ship demolition are given in Table 6-44.

6.1.1.10 Office Buildings. Office buildings generally provide working space for service-type organizations such as architectural, engineering, law, financial, and managerial organizations. In addition to individual offices, these buildings may also contain conference

TABLE 6-41. ASBESTOS MATERIALS IN CRUISE SHIP

Location of asbestos	Amount of asbestos	Type and thickness of asbestos
Turbines (2)	55.7 m^2 (600 ft^2)	7.6-cm (3-in.) premolded insulation
Pipes	9.3 m^2 (100 ft^2)	7.6-cm (3-in.) premolded insulation

TABLE 6-42. MODEL PARAMETERS FOR TURBINE OVERHAUL ON CRUISE SHIPS

Asbestos removed	
Turbines	4.2 m^3 (150 ft^3)
Pipes	0.7 m^3 (25 ft^3)
Asbestos waste generated	4.5 Mg (5 ton)

TABLE 6-43. ASBESTOS MATERIALS IN CARGO SHIP

Location of asbestos	Amount of asbestos	Type and thickness of asbestos
Bulkheads	2,787 m^2 (30,000 ft^2)	0.64-cm (1/4-in.) marine board
Equipment	1,300 m^2 (14,000 ft^2)	5-cm (2-in.) trowelled-on material
Pipes	2,415 m^2 (26,000 ft^2)	5-cm (2-in.) premolded insulation

TABLE 6-44. MODEL PARAMETERS FOR DEMOLITION OF CARGO SHIPS

Asbestos removed	
Walls	18 m^3 (625 ft^3)
Equipment	66 m^3 (2,333 ft^3)
Pipes	123 m^3 (4,333 ft^3)
Asbestos waste generated	184 Mg (203 ton)

rooms, cafeterias, and support facilities such as drafting and duplicating centers.

Asbestos was used in office buildings as acoustical ceiling treatments, fireproofing for steel frames, and thermal insulation on boilers, furnaces, and associated pipes and ducts. Office buildings range in size from small one-story wood frame structures to large, multistory, steel frame structures.

Models were developed to represent the demolition and renovating of small, medium, and large office buildings. The first is a small, one-story building with a steel frame and masonry veneer. The building is 3 m (10 ft) high and has a floor area of 669 m^2 (7,200 ft^2). The building has a partial basement that houses a boiler and other mechanical equipment. Table 6-45 shows the asbestos materials in the small office building and Tables 6-46 and 6-47 present model parameters for its demolition and renovation. Renovation will consist of replacement of the ceiling. For the renovation model, encapsulation of the ceiling is an alternative to asbestos removal. Demolition will be by front-end loader.

The second office building is a medium, five-story, reinforced concrete building with a total floor area of 3,344 m^2 (36,000 ft^2) on the five aboveground stories. The model is 18.3 m (60 ft) high and contains a partial basement that houses a boiler and other mechanical equipment. Table 6-48 lists the asbestos materials contained in the model. Tables 6-49 and 6-50 present model parameters for demolition and renovation of the building. Renovation will consist of replacing the ceiling. For the renovation model, encapsulation of the ceiling material is considered an alternative to removal. Demolition will be by ball and clam or floor by floor.

The third office building is a large, 20-story steel frame structure with a full basement. The model is 61 m (200 ft) high and has a total floor area of 26,756 m^2 (288,000 ft^2) excluding the basement. The basement contains two boilers and other mechanical equipment. Several storage areas are also located in the basement. Table 6-51 presents the asbestos materials contained in the large office building.

TABLE 6-45. ASBESTOS MATERIALS IN SMALL OFFICE BUILDINGS

Location of asbestos	Amount of asbestos	Type and thickness of asbestos
Boiler	9.3 m^2 (100 ft^2)	7.6-cm (3-in.) trowelled-on material
Boiler stack	3.7 m^2 (40 ft^2)	3.8-cm (1.5-in.) premolded insulation
Steam piping		
Exposed 5-cm (2-in.)	21.3 m (70 ft)	2.5-cm (1-in.) premolded insulation
Concealed 2.5-cm (1-in.)	66 m (250 ft)	2.5-cm (1-in.) premolded insulation
Hot water piping		
Concealed 2.5-cm (1-in.)	30.5 m (100 ft)	2.5-cm (1-in.) premolded insulation
Ceiling	669 m^2 (7,200 ft^2)	1.3-cm (0.5-in.) sprayed-on material

TABLE 6-46. MODEL PARAMETERS FOR DEMOLITION OF SMALL OFFICE BUILDING

Building area	669 m^2 (7,200 ft^2)
Abestos removed	
Boiler	0.71 m^3 (25 ft^3)
Stack	0.14 m^3 (5 ft^3)
Piping	0.43 m^3 (15.3 ft^3)
Ceiling	8.5 m^3 (300 ft^3)
Asbestos waste generated	8.7 Mg (9.6 ton)

TABLE 6-47. MODEL PARAMETERS FOR RENOVATION OF SMALL OFFICE BUILDINGS[a]

Building area	669 m^2 (7,200 ft^2)
Asbestos removed	
Ceiling	8.5 m^3 (300 ft^3)
Asbestos waste generated	7.6 Mg (8.3 ton)

[a]Encapsulation is an alternative to asbestos removal under which no asbestos is removed and no asbestos waste is generated.

TABLE 6-48. ASBESTOS MATERIALS IN MEDIUM OFFICE BUILDING

Location of asbestos	Amount of asbestos	Type and thickness of asbestos
Boiler	27.9 m^2 (300 ft^2)	7.6-cm (3-in.) trowelled-on material
Steam piping		
Exposed 7.6-cm (3-in.)	36.6 m (120 ft)	2.5-cm (1-in.) premolded insulation
Concealed 5-cm (2-in.)	30.5 m (100 ft)	2.5-cm (1-in.) premolded insulation
Concealed 2.5-cm (1-in.)	137.2 m (450 ft)	2.5-cm (1-in.) premolded insulation
Hot water piping		
Concealed 5-cm (2-in.)	45.7 m (150 ft)	2.5-cm (1-in.) premolded insulation
Concealed 2.5-cm (1-in.)	137.2 m (450 ft)	2.5-cm (1-in.) premolded insulation
Ceiling	3,344 m^2 (36,00 ft^2)	2.5-cm (1-in.) sprayed-on material

TABLE 6-49. MODEL PARAMETERS FOR DEMOLITION OF MEDIUM OFFICE BUILDING

Building area	3,344 m^2 (36,000 ft^2)
Asbestos removed	
Boilers	2.1 m^3 (75 ft^3)
Pipes	1.9 m^3 (66.2 ft^3)
Ceiling	84.9 m^3 (3,000 ft^3)
Asbestos waste generated	79.1 Mg (87.3 ton)

TABLE 6-50. MODEL PARAMETERS FOR RENOVATION OF MEDIUM OFFICE BUILDING[a]

Building area	3,344 m^2 (36,000 ft^2)
Asbestos removed	
Ceiling	84.9 m^3 (3,000 ft^3)
Asbestos waste generated	9 Mg (9.9 ton)

[a]Encapsulation is an alternative to asbestos removal under which asbestos is removed and no asbestos waste is generated.

TABLE 6-51. ASBESTOS MATERIALS IN LARGE OFFICE BUILDING

Location of asbestos	Amount of asbestos	Type and thickness of asbestos
Boiler (2)	74.3 m^2 (800 ft^2)	7.6-cm (3-in.) trowelled-on material
Steam piping		
Exposed 7.6-cm (3-in.)	110 m (360 ft)	2.5-cm (1-in.) premolded insulation
Concealed 5-cm (2-in.)	198 m (650 ft)	2.5-cm (1-in.) premolded insulation
Concealed 2.5 cm (1-in.)	1,006 m (3,300 ft)	2.5-cm (1-in.) premolded insulation
Hot water piping		
Concealed 5-cm (2-in.)	335 m (1,100 ft)	2.5-cm (1-in.) premolded insulation
Concealed 2.5-cm (1-in.)	1,006 m (3,300 ft)	2.5-cm (1-in.) premolded insulation
Structural steel		
30.5-cm (12-in.) columns	1,189 m (3,900 ft)	7.6-cm (3-in.) sprayed-on material
15.2-cm (6-in.) beams	17,678 m (58,000 ft)	3.8-cm (1.5-in.) sprayed-on material
Ceiling	26,756 m^2 (288,000 ft^2)	2.5-cm (1-in.) sprayed-on material

Tables 6-52 and 6-53 give model parameters for demolition and renovation of the building. Renovation will consist of replacing the ceiling. For the renovation model, encapsulation of the ceiling material is considered an alternative to removal. Demolition will be by implosion, ball and clam, or floor by floor.

6.1.1.11 Hospitals and Institutions. Hospitals and institutions are designed to provide overnight care for ill, injured, or otherwise disabled persons. In addition to general care rooms and wards, they have special areas set aside for emergency treatment, surgery, and other special functions. Hospitals and institutions are housed in buildings that range from small one-story structures to large, multi-story structures. Asbestos was used as fireproofing on steel frames; as thermal insulation on boilers, furnaces, and piping; and as acoustical treatments on ceilings.

Models were developed to represent the demolition and renovation of small, medium, and large hospitals and institutions. The first is small, a 10-bed hospital in a one-story structure with a total floor area 4,389 m^2 (14,400 ft^2). The hospital has a partial basement with a floor area of 74.3 m^2 (800 ft^2). A small boiler and other mechanical equipment are housed in the basement. Table 6-54 shows the amount of asbestos materials contained in the small hospital and Tables 6-55 and 6-56 present model parameters for its demolition and renovation, respectively. Demolition will be by front-end loader and renovation will consist of replacing the boiler, stack, and exposed steam piping.

The second hospital is a medium hospital with 200 beds in a three-story steel frame building. A small separate building adjacent to the main building houses two boilers and other mechanical equipment to support hospital operations. The main building is 9.8 m (32 ft) high and has a total floor area of 5,574 m^2 (60,000 ft^2). Table 6-57 shows the amount of asbestos materials in the medium hospital and Tables 6-58 and 6-59 present model parameters for demolition and renovation of the hospital. Demolition will be by ball and clam or floor by floor. Renovation will consist of replacing boiler, stacks, and exposed steam piping.

TABLE 6-52. MODEL PARAMETERS FOR DEMOLITION OF LARGE OFFICE BUILDING

Building area	26,756 m² (288,000 ft²)
Asbestos removed	
Boilers	5.7 m³ (200 ft³)
Pipes	12.3 m³ (434 ft³)
Structural steel	609 m³ (21,500 ft³)
Ceiling	679 m³ (24,000 ft³)
Asbestos waste generated	1,162 Mg (1,282 ton)

TABLE 6-53. MODEL PARAMETERS FOR RENOVATION OF LARGE OFFICE BUILDING[a]

Building area	26,756 m (288,000 ft²)
Asbestos removed	
Ceiling	679 m³ (24,000 ft³)
Asbestos waste generated	605 Mg (667 ton)

[a]Encapsulation is an alternative to asbestos removal under which no asbestos is removed and no asbestos waste is generated.

TABLE 6-54. ASBESTOS MATERIALS IN SMALL HOSPITAL

Location of asbestos	Amount of asbestos	Type and thickness of asbestos
Boiler	9.3 m^2 (100 ft^2)	7.6-cm (3-in.) trowelled-on material
Boiler stack	3.7 m^2 (40 ft^2)	3.8-cm (1.5-in.) premolded insulation
Steam piping		
Exposed 5-cm (2-in.)	21.3 m (70 ft)	2.5-cm (1-in.) premolded insulation
Concealed 2.5-cm (1-in.)	128 m (420 ft)	2.5-cm (1-in.) premolded insulation
Hot water piping		
Concealed 2.5-cm (1-in.)	183 m (600 ft)	2.5-cm (1-in.) premolded insulation
Ceiling	74.3 m^2 (800 ft^2)	1.3-cm (0.5-in.) trowelled-on material

TABLE 6-55. MODEL PARAMETERS FOR DEMOLITION OF SMALL HOSPITAL

Building area	1,338 m^2 (14,400 ft^2)
Asbestos removed	
Boiler	0.7 m^3 (25 ft^3)
Stack	0.1 m^3 (5 ft^3)
Piping	1.4 m^3 (49.1 ft^3)
Ceiling	0.9 m^3 (33.3 ft^3)
Asbestos waste generated	2.8 Mg (3.1 ton)

TABLE 6-56. MODEL PARAMETERS FOR RENOVATION OF SMALL HOSPITAL

Building area	1,338 m^2 (14,400 ft^2)
Asbestos removed	
Boiler	0.71 m^3 (25 ft^3)
Stack	0.14 m^3 (5 ft^3)
Piping	0.1 m^3 (3 ft^3)
Asbestos waste generated	0.8 Mg (0.9 ton)

TABLE 6-57. ASBESTOS MATERIALS IN MEDIUM HOSPITAL

Location of asbestos	Amount of asbestos	Type and thickness of asbestos
Boiler (2)	41.8 m^2 (450 ft^2)	7.6-cm (3-in.) trowelled-on material
Stacks (2)	9.3 m^2 (100 ft^2)	2.5-cm (1-in.) premolded insulation
Steam piping		
Exposed 7.6-cm (3-in.)	18.3 m (60 ft)	2.5-cm (1-in.) premolded insulation
Concealed 5-cm (2-in.)	457 m (1,500 ft)	2.5-cm (1-in.) premolded insulation
Concealed 2.5-cm (1-in.)	762 m (2,500 ft)	2.5-cm (1-in.) premolded insulation
Hot water piping		
Concealed 5-cm (2-in.)	457 m (1,500 ft)	2.5-cm (1-in.) premolded insulation
Concealed 2.5-cm (1-in.)	762 m (2,500 ft)	2.5-cm (1-in.) premolded insulation
Structural steel		
25.4-cm (10-in.) columns	2,865 m (9,400 ft)	6.4-cm (2.5-in.) sprayed-on material
15.2-cm (6-in.) beams	4,389 m (14,400 ft)	3.8-cm (1.5-in.) sprayed-on material

TABLE 6-58. MODEL PARAMETERS FOR DEMOLITION OF MEDIUM HOSPITAL

Building area	5,574 m² (60,000 ft²)
Asbestos removed	
Boiler	3.2 m³ (112 ft³)
Stack	0.2 m³ (8.3 ft³)
Piping	12 m³ (419 ft³)
Structural steel	322 m³ (11,380 ft³)
Asbestos waste generated	300 Mg (331 ton)

TABLE 6-59. MODEL PARAMETERS FOR RENOVATION OF MEDIUM HOSPITAL

Building area	5,574 m² (60,000 ft²)
Asbestos removal	
Boiler	3.2 m³ (112 ft³)
Stack	0.2 m³ (8.3 ft³)
Piping	0.1 m³ (3.9 ft³)
Asbestos waste generated	3.1 Mg (3.5 ton)

The third hospital is a large, 800-bed hospital in a metropolitan area. Contained in a seven-story reinforced concrete building, the hospital has a full basement that contains storage areas, two boilers, and other mechanical equipment. The building is 22 m (72 ft) high and has a total floor area of 29,357 m^2 (316,000 ft^2) in the seven above-ground stories (3,530 m^2 [38,000 ft^2] per story). Table 6-60 lists the amount of asbestos materials contained in the model and Tables 6-61 and 6-62 present model parameters for demolition and renovation of the model. Demolition will be by implosion, ball and clam, or floor by floor; renovation will consist of replacing the boilers, stacks, and exposed steam piping.

6.1.2 Milling

Asbestos milling is the process by which asbestos fibers are separated from the raw ore, through either a dry or wet process. The four existing U.S. plants have annual production capacities ranging from about 1,000 to 65,000 tons. Solid wastes are produced in the form of mill tailings and baghouse wastes. Tailings usually are wetted before being dumped onto the disposal pile, while baghouse wastes may be partly recycled to the process or may be wetted and transported to the tailings pile. Solid waste may be treated with chemical dust suppressants to prevent wind erosion.

Three model plants for asbestos mills are presented to cover the range in sizes of U.S. mills as well as the types of ore processing used. Two are typically sized plants, one of which uses a wet milling process and the other a dry process. The third model represents a small, dry mill. A typical asbestos mill may process ore at a rate of 280 ton/hr and have a production capacity of 65,000 ton/yr of raw asbestos fibers. Such a plant may operate 6,000 to 8,700 hr/yr and generate approximately 270 ton/hr of solid waste.

A small asbestos mill may process raw ore at a rate of 23 ton/hr and have a production capacity of 1,000 ton/yr of raw asbestos fibers. Plants may operate 4,000 to 8,000 hr/yr and generate approximately 22.8 ton/hr solid waste. Table 6-63 presents operating parameters for the model asbestos mills.

TABLE 6-60. ASBESTOS MATERIALS IN LARGE HOSPITAL

Location of asbestos	Amount of asbestos	Type and thickness of asbestos
Boilers (2)	83.6 m^2 (900 ft^2)	7.6-cm (3-in.) trowelled-on material
Stacks (2)	20.9 m^2 (225 ft^2)	2.5-cm (1-in.) premolded insulation
Steam piping		
Exposed 7.6-cm (3-in.)	122 m (400 ft)	2.5-cm (1-in.) premolded insulation
Concealed 5-cm (2-in.)	2,006 m (6,580 ft)	2.5-cm (1-in.) premolded insulation
Concealed 2.5-cm (1-in.)	7,315 m (24,000 ft)	2.5-cm (1-in.) premolded insulation
Hot water piping		
Exposed 5-cm (2-in.)	12[illegible] (400 ft)	2.5-cm (1-in.) premolded insulation
Concealed 5-cm (2-in.)	2,006 m (6,580 ft)	2.5-cm (1-in.) premolded insulation
Concealed 2.5-cm	7,315 m (24,000 ft)	2.5-cm (1-in.) premolded insulation
Ceiling	3,530 m^2 (38,000 ft^2)	1.3-cm (0.5-in.) sprayed-on material

TABLE 6-61. MODEL PARAMETERS FOR DEMOLITION OF LARGE HOSPITAL

Building area	31,293 m^2 (316,000 ft^2)
Asbestos removed	
Boilers	6.4 m^3 (225 ft^3)
Stacks	0.5 m^3 (18.8 ft^3)
Piping	85.4 m^3 (3,015 ft^3)
Ceiling	44.8 m^3 (1,583 ft^3)
Asbestos waste generated	112 Mg (134 ton)

TABLE 6-62. MODEL PARAMETERS FOR RENOVATION OF LARGE HOSPITAL

Building area	31,293 m^2 (316,000 ft^2)
Asbestos removed	
Boilers	6.4 m^3 (225 ft^3)
Stacks	0.5 m^3 (18.8 ft^3)
Piping	0.7 m^3 (26.2 ft^3)
Asbestos waste generated	6.8 Mg (7.5 ton)

TABLE 6-63. OPERATING PARAMETERS FOR ASBESTOS MILLS

Small asbestos mill	
Plant capacity	1,000 ton/yr
Annual production	700 tons
Solid waste generated	14,000 ton/yr
Annual operating hours	6,100
Typical asbestos mill	
Plant capacity	65,000 ton/yr
Annual production	40,000 tons
Solid waste generated	1,700,000 ton/yr
Annual operating hours	6,240

6.1.3 Manufacturing

6.1.3.1 Paper Manufacturing. The manufacturing of paper products is carried out by processes very similar to those used in other paper manufacturing operations. Asbestos fibers are mixed with water and other ingredients, and the slurry is then processed into paper. Existing plants have production capacities ranging from about 550 to 140,000 ton/yr. In some plants dry asbestos fibers are dumped from bags into the process stream, while in other plants pulpable bags are used and the unopened bags are added to the papermaking process. If bag dumping is employed, the mixing process must be controlled by local exhaust ventilation (LEV) systems and the air sent to a purifying system before being recycled or exhausted. In these cases, solid waste is generated in the emission control system and by the empty bags. Other solid wastes are generated by purification of process wastewater. If pulpable bags are used, LEV systems are not required and the only solid waste is produced through purification of process wastewater. Baghouse wastes normally are returned to the manufacturing process, and wastewater sludge normally is disposed of at a landfill. A small amount of solid waste is generated from waste products, but most of it can be recycled into the manufacturing process.

Model plants were developed for three sizes of paper manufacturing plants. A small plant may produce 3,000 to 6,000 ton/yr of product and consume about 3,750 to 7,500 ton/yr of raw asbestos fibers. Annual operating hours may range from 4,000 to 6,000, and solid waste generation may range from 4 to 7 ton/yr. Waste is hauled to a public or private offsite landfill or is disposed of onsite.

A typical plant may produce 15,000 to 25,000 ton/yr of paper and consume 11,000 to 16,000 ton/yr of raw asbestos fibers. Annual operating hours may range from 4,000 to 6,000, and solid waste generation may range from 18 to 30 ton/yr. Waste is hauled to an offsite landfill for disposal.

A large plant may produce from 65,000 to 115,000 ton/yr of paper and consume 48,000 to 85,000 ton/yr of raw asbestos fibers. Annual operating hours may range from 4,000 to 6,000 and waste generation may range from 78 to 138 ton/yr. Waste is hauled to an offsite landfill for disposal. Table 6-64 presents operating parameters for the three sizes of model plants.

6.1.3.2 Friction Materials Manufacturing. The manufacture of friction materials begins when asbestos fibers are mixed with other raw materials to produce a slurry, which is then formed or molded into the friction product and dried or cured. Finished products then pass through finishing operations and are packaged. LEV systems are used on many of the operations to control worker exposure to asbestos fibers. Exhausts from the LEV systems are passed through baghouses or wet scrubbers. Solid wastes consist of product scrap, baghouse and vacuum cleaner material, wastewater solids, and empty asbestos bags. Friction material wastes normally are not recycled to the manufacturing process.

Three sizes of model plants were developed for friction material manufacturing. The small model plant has two variations: one with onsite and one with offsite solid waste disposal. Small plants have a production capacity ranging from 800 to 1,500 ton/yr and consume 520 to 1,000 ton/yr of asbestos. Plants operate 4,000 to 6,000 hr/yr and generate 88 to 165 ton/yr of solid waste.

A typical friction products manufacturing plant may produce 2,500 to 4,000 ton/yr of product and consume 1,600 to 2,600 ton/yr of asbestos. Annual operating hours may range from 4,000 to 6,000, and solid waste generation may range from 275 to 440 ton/yr. Asbestos waste is disposed of in an offsite landfill.

A large plant may produce 5,000 to 10,000 ton/yr of friction materials and consume 3,200 to 6,500 ton/yr of asbestos. Annual operating hours may range from 4,000 to 6,000, and solid waste generation may range from 550 to 1,100 ton/yr. An offsite landfill is used for disposal of asbestos-containing waste. Operating parameters for the three sizes of model plants are given in Table 6-65.

6.1.3.3 A/C Products Manufacturing. A/C products consist mainly of sheet and pipe. The manufacturing process for both products involves

TABLE 6-64. MODEL PLANT PARAMETERS FOR ASBESTOS PAPER MANUFACTURING PLANTS

Small paper manufacturing plant	
Production capacity	6,475 ton/yr
Annual production	3,700 tons
Asbestos consumed	2,760 ton/yr
Solid waste generated	4.4 ton/yr
Annual operating hours	5,760
Typical paper manufacturing plant	
Production capacity	32,400 ton/yr
Annual production	18,500 tons
Asbestos consumed	13,800 ton/yr
Solid waste generated	22 ton/yr
Annual operating hours	5,760
Large paper manufacturing plant	
Production capacity	130,000 ton/yr
Annual production	74,300 tons
Asbestos consumed	55,450 ton/yr
Solid waste generated	89 ton/yr
Annual operating hours	5,760

TABLE 6-65. MODEL PLANT PARAMETERS FOR ASBESTOS FRICTION MATERIALS MANUFACTURING PLANTS

Small friction materials manufacturing plant	
Production capacity	2,450 ton/yr
Annual production	1,250 tons
Asbestos consumed	800 ton/yr
Solid waste generated	135 ton/yr
Annual operating hours	5,520
Typical friction materials manufacturing plant	
Production capacity	6,000 ton/yr
Annual production	3,100 tons
Asbestos consumed	2,000 ton/yr
Solid waste generated	340 ton/yr
Annual operating hours	5,520
Large friction materials manufacturing plant	
Production capacity	14,700 ton/yr
Annual production	7,500 tons
Asbestos consumed	4,800 ton/yr
Solid waste generated	825 ton/yr
Annual operating hours	5,520

mixing of asbestos fibers with other ingredients to form a slurry, which is formed into sheet or pipe and then dried or cured. The products may then pass through one or more finishing operations. Solid waste is generated by scrap material, baghouse and vacuum cleaner wastes, wastewater solids, and empty bags. Because plant sizes do not vary greatly across the industry, model plants represent typical A/C pipe and sheet manufacturing plants. Each model plant has two variations: onsite and offsite solid waste disposal.

A typical A/C pipe manufacturing plant may produce 75,000 to 125,000 ton/yr and consume 15,000 to 25,000 ton/yr of raw asbestos fibers. Annual operating hours may range from 5,000 to 8,000, and annual solid waste generation may range from 1,000 to 2,000 tons.

A typical A/C sheet manufacturing plant may produce 5,000 to 10,000 ton/yr of A/C sheet and consume 1,250 to 2,500 ton/yr of raw asbestos fibers. Annual operating hours may range from 5,000 to 8,000, and annual solid waste generation may range from 250 to 500 tons. Table 6-66 presents operating parameters for the model plants.

6.1.3.4 V/A Floor Tile Manufacturing. In the manufacturing of V/A floor tile, raw asbestos fibers are mixed with other ingredients to form a slurry, which is formed into sheets, calendared to desired thickness, cooled, and cut into squares. Dry asbestos fibers may be emptied into the process or fibers may be introduced in unopened bags. Most product scrap is recycled into the manufacturing process, so solid waste generation is extremely small. Solid waste consists mostly of baghouse and vacuum cleaner waste and of empty bags when bag emptying is practiced. Model plants were developed for small and typical operations. Waste disposal for both models is in an offsite landfill.

A small V/A floor tile manufacturing plant may produce 5,000 to 10,000 ton/yr of tile and consume 600 to 1,200 ton/yr of raw asbestos fibers. Annual operating hours may range from 4,000 to 7,000, and solid waste generation may range from 4 to 7 ton/yr.

A typical V/A floor tile plant may produce 20,000 to 40,000 ton/yr of product and consume 2,400 to 4,800 ton/yr of raw asbestos

TABLE 6-66. MODEL PLANT PARAMETERS FOR A/C PRODUCTS MANUFACTURING

Typical A/C pipe manufacturing plant	
Production capacity	150,000 ton/yr
Annual production	100,000 tons
Asbestos consumed	20,000 ton/yr
Solid waste generated	1,500 ton/yr
Annual operating hours	7,344
Typical A/C sheet manufacturing plant	
Production capacity	10,000 ton/yr
Annual production	7,000 tons
Asbestos consumed	1,750 ton/yr
Solid waste generated	350 ton/yr
Annual operating hours	7,344

fibers. Annual operating hours may range from 4,000 to 7,000, and solid waste generation may range from 15 to 30 ton/yr. Table 6-67 presents operating parameters for two model plants.

6.1.3.5 Asbestos-Reinforced Plastics (Phenolic Molding Compounds). Asbestos fibers are added to phenolic molding compounds to provide strength, durability, and dimensional stability. Dry asbestos fibers are added to the other ingredients in dry form, and the mixture is then processed into the plastic products by molding or extrusion. Products may pass through several finishing operations after forming and curing are completed. Dust-generating operations are controlled by LEV systems, which typically are vented to baghouses. Solid waste consists of baghouse waste, scrap product, and empty bags. Baghouse waste typically is recycled into the manufacturing process. Other solid waste normally is disposed of in an offsite landfill. Model plants were developed for small and typical manufacturers of phenolic molding compounds. A small plant may produce 300 to 600 ton/yr of reinforced plastic and consume 60 to 120 ton/yr of raw asbestos fibers. Annual operating hours may range from 3,600 to 7,200, and annual waste generation may range from 18 to 36 tons.

A typical plant may produce 1,500 to 2,500 ton/yr of reinforced plastic and consume 300 to 500 ton/yr of raw asbestos fibers. Annual operation hours may range from 4,000 to 8,000, and solid waste generation may range from 90 to 150 ton/yr. Table 6-68 shows operating parameters for the two model plants.

6.1.3.6 Coatings and Sealants Manufacturing. Asbestos fibers are mixed with other ingredients, mostly asphalt materials, to form the end product for this industry segment. Bag opening and mixing processes are exhausted to baghouses. Baghouse waste is recycled to the manufacturing process, so the only solid waste to be disposed of is empty bags, which normally are landfilled offsite. Because existing plants do not vary substantially in size, a single model plant is used to represent a typical coatings and sealant manufacturer.

Annually, a typical plant may produce 3 to 6 million gallons of product and consume 1,200 to 2,400 tons of asbestos. Annual operating

TABLE 6-67. MODEL PLANT PARAMETERS FOR V/A FLOOR TILE MANUFACTURING

Small V/A floor tile manufacturing plant	
Production capacity	16,000 ton/yr
Annual production	9,000 tons
Asbestos consumed	1,000 ton/yr
Solid waste generated	6 ton/yr
Annual operating hours	6,000
Typical V/A floor tile manufacturing plant	
Production capacity	50,000 ton/yr
Annual production	30,000 tons
Asbestos consumed	3,600 ton/yr
Solid waste generated	22 ton/yr
Annual operating hours	6,000

TABLE 6-68. MODEL PLANT PARAMETERS FOR PHENOLIC MOLDING COMPOUND MANUFACTURING

Small phenolic molding compound manufacturing plant	
Production capacity	800 ton/yr
Annual production	450 tons
Asbestos consumed	90 ton/yr
Solid waste generated	25 ton/yr
Annual operating hours	6,000
Typical phenolic molding compound manufacturing plant	
Production capacity	3,000 ton/yr
Annual production	1,800 tons
Asbestos consumed	360 ton/yr
Solid waste generated	100 ton/yr
Annual operating hours	6,000

hours average about 6,000. No data are available concerning the quantity of empty bags for disposal. Table 6-69 presents operating parameters for the model plant.

6.1.3.7 Gaskets and Packings Manufacturing. Asbestos gaskets are produced by the combination of asbestos fibers with other ingredients to form a mixture that is calendared into a sheet and cut to desired shapes. Solid waste from the process consists of scrap product, baghouse wastes, and empty bags. Packings are made by impregnating dry asbestos yarn with lubricants and braiding the yarn into the packing, which is then calendared to desired sizes and shapes. Product scrap is the major source of solid waste, which is disposed of in offsite landfills. A model plant was developed to represent a typical manufacturer of asbestos packings and gaskets. A typical plant may produce 400 to 800 ton/yr of product and consume 340 to 680 ton/yr of asbestos. Annual operating hours may range from 4,000 to 8,000, and annual waste generated may range from 18 to 36 tons. Operating parameters for the model plant are given in Table 6-70.

6.1.3.8 Asbestos Textiles Manufacturing. Asbestos textiles generally are manufactured by the conventional dry process used in other textile operations. A small fraction is produced through a wet process whereby asbestos fibers are mixed into a slurry, which is then extruded to form yarn. Solid waste is generated by product scrap, baghouse waste, and empty bags. Some of the baghouse wastes are recycled into the manufacturing process. A model plant for asbestos textiles was developed to represent a typical existing plant. A typical plant may produce 200 to 500 ton/yr of asbestos textiles and consume 170 to 425 ton/yr of raw asbestos fibers. Annual operating hours may range from 3,000 to 6,000 and annual solid waste generation may range from 10 to 25 tons. Waste may be disposed of either onsite or offsite. Model plant operating parameters are given in Table 6-71.

6.1.3.9 Chlorine Manufacturing. One of the major chlorine manufacturing methods employs an asbestos diaphragm in the process. LEV systems are used to control worker exposure in bag opening and mixing operations. The LEV system exhaust is filtered before being

TABLE 6-69. MODEL PLANT PARAMETERS FOR COATINGS AND SEALANTS MANUFACTURING

	Typical coatings and sealants manufacturing plant
Production capacity	10,000,000 gal/yr
Annual production	5,400,000 gallons
Asbestos consumed	2,200 ton/yr
Solid waste generated	
Annual operating hours	6,000

TABLE 6-70. MODEL PLANT PARAMETERS FOR PACKINGS AND GASKETS MANUFACTURING

	Typical packings and gaskets manufacturing plant
Production capacity	1,000 ton/yr
Annual production	600 tons
Asbestos consumed	510 ton/yr
Solid waste generated	27 ton/yr
Annual operating hours	6,000

TABLE 6-71. MODEL PLANT PARAMETERS FOR ASBESTOS TEXTILE PLANT

	Typical asbestos textile plant
Production capacity	700 ton/yr
Annual production	350 tons
Asbestos consumed	300 ton/yr
Solid waste generated	18 ton/yr
Annual operating hours	4,000

TABLE 6-72. MODEL PLANT PARAMETERS FOR CHLORINE MANUFACTURING PLANT

	Typical coatings and sealants manufacturing plant
Production capacity	450,000 ton/yr
Annual production	260,000 tons
Asbestos consumed	130 ton/yr
Solid waste generated	130 ton/yr
Annual operating hours	7,200

recycled or exhausted to the atmosphere. The asbestos diaphragms must be replaced periodically and constitute the major source of solid waste. Other solid waste consists of LEV system filters, vacuum cleaner waste, and empty bags. An offsite landfill is used for disposal of asbestos waste. All of the asbestos consumed in the process must be disposed of in the form of solid waste. A model plant was developed to represent a typical chlorine manufacturing plant.

Annually, a typical plant may produce 200,000 to 400,000 tons of chlorine and consume 100 to 200 tons of asbestos. Annual operating hours may range from 6,000 to 8,000, and annual solid waste generation may range from 100 to 200 tons. Operating parameters for a typical chlorine manufacturing plant are given in Table 6-72.

6.1.4 Fabricating Processes

Model plants were developed for three types of secondary fabricators of asbestos products: friction products, A/C building products, and A/C or asbestos-silicate boards.

6.1.4.1 Friction Products. Secondary fabrication of friction products mostly involves rebuilding of automotive brakes and clutches, with brakes the major component. Automotive brake rebuilding consists of applying new brake linings on used brake shoes. In the process, remnants of the old brake linings are removed from the shoes, new linings are installed, and the linings are ground to the proper shape. Solid waste is generated by removal of the old linings and by the grinding operations.

A typically sized brake-rebuilding operation may produce 300,000 to 500,000 brake shoes per year. No raw asbestos fibers are consumed in the process. The plant may operate 5,000 to 7,200 hr/yr and generate 5 to 8 ton/yr of solid waste, which is disposed of offsite. Operating parameters for a model brake-shoe-rebuilding plant are given in Table 6-73.

6.1.4.2 A/C Building Products. In some cases, construction contractors specify that A/C building products be prefabricated to eliminate or greatly reduce field fabrication of the products. Prefabrication normally is at central shops operated by distributors of A/C building products. Solid waste is generated by sawing and drilling operations and by product scrap.

TABLE 6-73. MODEL PLANT PARAMETERS FOR BRAKE-SHOE-REBUILDING PLANT

	Typical brake-shoe-rebuilding plant
Production capacity	800,000 shoes/yr
Annual production	440,000 shoes
Solid waste generated	7.35 ton/yr
Annual operating hours	6,000

TABLE 6-74. MODEL PLANT PARAMETERS FOR PREFABRICATOR OF A/C BUILDING PRODUCTS

	Typical prefabrication of A/C building products
Production capacity	50 ton/yr
Annual production	20 tons
Solid waste generated	3.4 ton/yr
Annual operating hours	2,400

TABLE 6-75. MODEL PLANT PARAMETERS FOR ASBESTOS BOARD FABRICATION

	Typical asbestos board fabrication
Production capacity	300 ton/yr
Annual production	135 tons
Solid waste generated	35 ton/yr
Annual operating hours	2,400

A typical prefabricator of A/C building products might prefabricate 15 to 30 ton/yr of A/C building products. Annual o erating hours may range from 2,000 to 4,000, and solid waste generation may range from 2.5 to 5 ton/yr. Asbestos waste is hauled to an offsite landfill for disposal. Operating parameters for a typical prefabricator of A/C building products are given in Table 6-74.

6.1.4.3 A/C and Asbestos Silicate Boards. Both A/C and asbestos-silicate boards are used by a number of secondary fabricators. These boards are used for exhaust hoods in corrosive atmospheres, laboratory furniture, molten metal flow control systems, ovens, and electrical panels. Larger users of asbestos boards have their own fabricating shops, while other users have the boards fabricated to specifications by central specialty shops.

A single model plant was developed to represent a typical fabricator of asbestos boards. Solid waste is generated by these fabricators from sawing, drilling, and machining operations. The solid waste may be disposed of in either onsite or offsite landfills. A typical asbestos fabricator may use 100 to 200 ton/yr of board. Annual operating hours may range from 2,000 to 3,000, and solid waste generation may range from 25 to 50 ton/yr. Operating parameters for a typical fabricator of asbestos boards are given in Table 6-75.

6.1.5 Waste Disposal Sites

Asbestos-containing solid waste is generated by demolition and renovation activities, by manufacturing operations, and by fabrication of asbestos-containing materials. Solid waste from demolition and renovation consists mostly of friable asbestos materials removed from boilers, vessels, pipes, ceilings, walls, and structural members. Solid waste from manufacturing operations consists of scrap product, baghouse and vacuum cleaner wastes, process wastewater solids, and bags emptied of asbestos. Fabrication of asbestos-containing products generates baghouse and vacuum cleaner waste and scrap product.

Solid waste from all of the above sources normally is disposed of at landfills. Demolition and renovation wastes normally are hauled to publicly or privately owned landfills near the demolition or renovation activity. Hauling may be by the contractor or by a licensed waste hauler. Manufacturing and fabricating waste may be disposed of at onsite landfills operated by the company or at offsite landfills. If offsite landfills are used, hauling may be contracted to a hauler or may be done in company trucks by company employees.

Two model waste disposal sites were developed. One is a small privately owned landfill and the other is a large publicly owned landfill. Both accept wastes from many sources.

The small private landfill handles the waste disposal needs of a small town located nearby. The facility handles approximately 50 tons of waste per day and only about 5 tons of asbestos waste per week. The landfill requires that all asbestos waste be sealed in plastic bags and contained in fiber drums. Asbestos waste is unloaded and placed with other waste and is covered at the end of each work day.

The public landfill is a large sanitary landfill that accepts asbestos-containing waste in a separate area of the site. All asbestos waste must be in sealed containers to be accepted by the landfill. Containers are unloaded by hand and are covered with earth at the end of each day. The landfill disposes of approximately 1,000 tons of waste daily but only 40 to 50 tons of asbestos waste weekly. The asbestos waste comes mostly from demolition and renovation work.

6.2 REGULATORY ALTERNATIVES

This section discusses, in order of increasing stringency, regulatory alternatives to be considered for the asbestos source category. The variety of potential asbestos emission sources (e.g., milling, demolition, and waste disposal), dictates that a variety of control options be considered in each regulatory alternative. Regulatory alternatives are summarized in Table 6-76. Environmental impacts are discussed in Chapter 7 and costs are presented in Chapter 8.

6.2.1 Regulatory Alternative I

This alternative is baseline and is the same as the current NESHAP. Although some States have adopted their own asbestos regulations, these State regulations are essentially equivalent to the NESHAP in that States have adopted the NESHAP by reference, reprinted

TABLE 6-76. SUMMARY OF REGULATORY ALTERNATIVES--ASBESTOS NESHAP

Regulatory alternative	Category: Mills	Roadways	Manufacturing	Demolition	Renovation	Insulation	Spraying	Fabricating	Waste disposal (waste generators)	Inactive waste disposal sites	Waste disposal sites	Encapsulation
I	Baseline[a]	Baseline[a]	Baseline[a]	Baseline[a]	Baseline[a]	Baseline[a]	Baseline[a]	Baseline[a]	Baseline[a]	Baseline[a]	Baseline[a]	Baseline[a]
II	Same as I	Same as I	Same as I	Same as I, plus: · Notification changes	Same as I, plus: · Notification changes	Same as I	Same as I	Same as I	Same as I, plus: · Containment of waste for transport	Same as I, plus: · Permanent record of site	Same as I, plus: · Containment of transported waste · Permanent record of site	Same as I, plus: · Notification · Barriers · Exhaust ventilation
III	Same as I	Same as I	Same as I	Same as II, plus: · Wetting exception requirements (exhaust ventilation)	Same as II, plus: · Wetting exception requirements (exhaust ventilation)	Same as I	Same as I, plus: · Ban on spraying of material containing more than 1 percent asbestos (resinous and bituminous coatings exempt)	Same as I	Same as II, plus: · Recordkeeping requirements	Same as II, plus: · Final cover requirements	Same as II, plus: · Recordkeeping requirements · Final cover requirements	Same as II, plus: · Record of location of asbestos
IV	Same as I, plus: · HEPA filter requirements	Same as I	Same as I, plus: · HEPA filter requirements	Same as III, plus: · HEPA filter requirements · Size cutoff change · Detection recordkeeping requirements	Same as IV, plus: · HEPA filter requirements · Size cutoff change · Detection recordkeeping requirements	Same as I	Same as III, plus: · Ban on material containing any asbestos (resinous and bituminous coatings exempt)	Same as I, plus: · HEPA filter requirements	Same as III	Same as IV	Same as IV, plus: · Observation of waste unloading	Same as IV

[a]Baseline = Current NESHAP.

the NESHAP in their own State regulations, or adopted the NESHAP with some modifications.

6.2.2 Regulatory Alternative II

This alternative consists of baseline plus several relatively minor charges. Under the demolition and renovation categories, the following changes in notification requirements are selected:

- Notification by telephone of intent to demolish or renovate at least 5 working days prior to commencement of demolition or renovation when the amount of asbestos exceeds the size cutoff, followed by written confirmation postmarked 5 working days prior to commencement.
- Notification by telephone of intent to demolish or renovate at least 10 working days prior to commencement of demolition or renovation when the amount of asbestos is less than the size cutoff, followed by written confirmation postmarked 10 working days prior to commencement.
- Notification by telephone as early as possible prior to commencement of emergency demolition of a structurally unsound facility in danger of imminent collapse.

Principal changes here are in the use of the telephone for notification of intent to demolish or renovate and the minimum time between notification and commencement of demolition or renovation. However, the change in the notification period is not drastic because allowing telephone notification reduces lead time and specifying "working days" rather than just "days" excludes weekends from the notification period. Written confirmation of intent to demolish or renovate would also be required but would be received by EPA after the telephone notice.

Regulatory Alternative II would also require sources of asbestos waste to ensure the proper loading and containment of waste for transport to disposal sites in order to prevent fugitive asbestos emissions. This provision would not directly regulate transporters of asbestos waste, nor would it replace the current NESHAP provision requiring generators of waste to meet either the no visible emission limit or the NESHAP disposal method requirements. Furthermore, waste disposal site owners or operators would be required to report to the Administrator the name of any transporter that arrives at a disposal site with asbestos waste that is not acceptable for unloading. This requirement would not preclude disposal of the improperly contained waste at the disposal site.

Regulatory Alternative II further requires that both active and inactive asbestos waste disposal sites record permanently the exact location of the asbestos waste to alert future land users of the presence of asbestos. This information would be recorded on the property deed for both active and inactive sites.

Regulatory Alternative II would regulate encapsulation of asbestos-covered surfaces with a nonasbestos sealant, an activity not covered by the current NESHAP. Encapsulation is a method for suppressing the release of asbestos fibers from suitable asbestos-covered surfaces and is used as an alternative to removing the asbestos in some instances because its initial cost is low and some asbestos is inaccessible for removal. However, application of encapsulants can cause release of asbestos fibers. Notice of intent to encapsulate would be required by telephone at least 5 working days prior to commencement of encapsulation followed by written confirmation postmarked 5 working days prior to commencement. The following information would be required for both the telephone notice and the written confirmation:

- Name and address of owner or operator.
- Description and location of facility having encapsulation work done including the size, age, and current use of the facility.
- Estimated amount of asbestos material being encapsulated.
- Scheduled starting and completion dates of encapsulation.

This alternative would also require the erection of barriers sufficient to contain the work area and the use of space exhaust ventilation to maintain the work area under negative pressure. If exhausted to the outside air, no visible emissions or air-cleaning devices would be required.

6.2.3 Regulatory Alternative III

This alternative includes all of the control options of Regulatory Alternative II plus additional, more stringent, options. Exemption from the wetting requirements for demolition and renovation due to freezing temperatures would be deleted and exemption from the wetting requirements for renovation due to equipment damage would be changed. Wetting asbestos prior to stripping would continue to be required as the principal method of controlling asbestos emissions. If wetting is impractical because of freezing weather, potential for equipment damage, or unsafe conditions, space exhaust ventilation and collection system would be required. Any space exhaust ventilation system would have to be used in conjunction with an enclosure system that isolates the work area and allows it to be kept under negative pressure. If exhausted outdoors, no visible emissions would be allowed from the collection system or it would be required to meet certain equipment standards.

The spraying of all materials containing significant quantities of commercial asbestos would be banned under Alternative III, except for resinous and bituminous coatings that contain asbestos and that are not friable after drying. The standard currently allows the spraying of asbestos-containing material on equipment and machinery, including friable materials.

To facilitate surveillance, Regulatory Alternative III would require that the generator of asbestos waste and the waste disposal site operator keep records of all asbestos waste. The waste generator would be required to keep records of each waste load, including the amount, its destination, and the carrier's name. The disposal-site owner or operator would be required to keep records of each load of asbestos waste received, including the amount, the generator's name, and the carrier's name.

Alternative III would require that 2 feet of topsoil be placed over asbestos waste as a final cover at inactive asbestos waste disposal sites and that the cover be vegetated.

This alternative also would require that where asbestos material has been encapsulated, the location of that asbestos material be included on some permanent record so future owners will be aware of its presence.

6.2.4 Regulatory Alternative IV

This alternative is the most stringent. In addition to the requirements of Alternative III, it would require high-efficiency particulate air (HEPA) filters as final filters to all air-cleaning devices used in milling, manufacturing and fabricating, and demolition and renovation.

Alternative IV would increase coverage by the NESHAP by reducing the size cutoff above which owners and operators of demolition and renovation jobs must comply with the standard. The size cutoff would be lowered to 5 ft^2, which would effectively eliminate the exemption for apartment buildings of four or fewer dwelling units.

Asbestos detection recordkeeping would be required for demolition and renovation. The records would show that prior to demolition or renovation, the building was inspected for asbestos and would include results of laboratory analysis (polarized light microscopy and/or X-ray diffraction) performed on bulk samples of materials suspected to contain asbestos.

The spraying of all materials containing asbestos (as measured by a reference method to be proposed), even contaminant asbestos, would be banned under Alternative IV, except for resinous and bituminous coatings that contain asbestos and that are not friable after drying.

Under Alternative IV, waste-disposal-site operators would be responsible for observing waste unloading in addition to measures required in Alternative III. This requirement would ensure that containers are not unloaded carelessly and that measures are taken immediately if containers break or if the waste is otherwise improperly unloaded, causing emissions to the atmosphere.

ENCLOSURE 3

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TABLE 1. DETAILED COSTS FOR NESHAP DEMOLITION AND RENOVATION MODELS
Cost ($)

Cost Element	Small School	Medium School	Large School	Small Hotel	Large Hotel	Department Store	Small Grocery	5-unit Apartment	50-unit Apartment	Small Office Bldg.	Medium Office Bldg.	Large Office Bldg.	Small Hospital	Medium Hospital	Large Hospit[al]
1. Friable Materials Survey	116	332	732	187	597	177	25	25	135	25	97	778	39	162	8[illegible]
2. Sampling and Analysis	375	1,275	1,275	525	675	525	375	375	525	450	525	675	450	750	6[illegible]
3. Bid Spec Preparation	283	868	981	27	500	25	25	47	457	49	263	2,709	25	323	4[illegible]
4. Notification	50	50	50	50	50	50	50	50	50	50	50	50	50	50	[illegible]
5. Enclosures	9,072	25,788	56,910	14,557	46,449	13,797	588	1,732	10,500	1,512	7,560	60,480	3,024	12,400	66,[illegible]
6. Space Exhaust	2,592	7,368	16,260	4,159	13,271	3,942	168	495	3,000	432	2,160	17,280	864	3,600	18,[illegible]
7. Exposing Concealed Asbestos	1,025	13,405	29,950	1,130	3,280	300	70	105	21,542	175	575	43,200	510	4,000	30,[illegible]
8. Asbestos Removal and Bagging															
a. Ceiling	151,200	388,850	136,812	8,400	13,125	--	--	26,250	175,000	25,200	126,000	1,008,000	2,800	--	133,[illegible]
b. Pipe Insulation	3,290	4,767	10,580	3,641	10,588	1,209	321	536	2,570	643	1,943	13,326	1,668	12,332	94,[illegible]
c. Boilers & Structural	76	48,531	107,692	334	91,094	122	106	103	20,925	106	228	117,293	106	52,148	8[illegible]
9. Waste Disposal	20,700	85,200	325,800	67,200	194,400	750	450	2,100	65,100	3,900	34,800	510,000	1,200	132,100	21,3[illegible]
10. Demolition Cost without NESHAP	155,520	442,080	975,600	207,960	718,848	197,100	5,400	24,750	150,000	21,600	108,000	864,000	43,200	180,000	948,0[illegible]

TABLE 1. DETAILED COSTS FOR NESHAP DEMOLITION AND RENOVATION MODELS (Continued)
Cost ($)

Cost Element	Single Unit Dwelling A	B	C	Small Power Plant	Medium Power Plant	Small Industrial Boiler	Medium Industrial Boiler	Small Refinery	Medium Refinery	Cruise Ship	Cargo Ship
1. Friable Materials Survey	25	25	25	--	--	--	--	--	--	--	--
2. Sampling and Analysis	300	300	300	300	300	225	225	--	--	--	--
3. Bid Spec Preparation	--	--	--	--	--	--	--	--	--	--	--
4. Notification	50	50	50	50	50	50	50	50	50	50	50
5. Enclosures	270	270	270	2,609	36,729	131	336	247,590	956,508	1,512	21,000
6. Space Exhaust	77	77	77	745	10,494	38	96	70,740	273,288	432	6,000
7. Exposing Concealed Asbestos	--	--	--	--	--	--	--	--	--	--	--
8. Asbestos Removal and Bagging											
a. Ceiling	--	--	4,508	--	--	--	--	--	--	--	30,000
b. Pipe Insulation	--	--	--	3,210	42,800	1,070	6,315	768,346	3,367,162	214	27,820
c. Boilers & Structural	183	575	1,759	782	11,780	1,303	8,117	165,397	450,112	456	10,640
9. Waste Disposal	948	1,430	7,540	6,900	260,700	4,500	28,800	295,866	1,116,072	1,950	81,000
10. Demolition Cost without NESHAP	1,932	1,932	1,932	14,415	92,200	1,385	8,130	1,554,061	6,369,897		

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TABLE 2. COSTS OF REGULATORY ALTERNATIVES FOR DEMOLITION AND RENOVATION MODELS

Cost Element	Small School	Medium School	Large School	Small Hotel	Large Hotel	Department Store	Small Grocery
olition							
Baseline	332,635	985,758	1,589,480	289,454	1,033,157	200,258	9,[illegible]2
Alternative II	332,635	985,758	1,589,480	289,454	1,033,157	200,258	9,822
Alternative III	344,299	1,018,914	1,662,650	308,170	1,092,877	217,997	10,578
Alternative IV	344,324	1,018,939	1,662,675	308,195	1,092,902	218,022	10,603
ovation							
Baseline	172,124	442,975	253,250	11,773	19,398	1,534	1,048
Alternative II	172,124	442,975	253,250	11,773	19,398	1,534	1,048
Alternative III	183,788	476,131	326,420	30,489	79,118	19,273	1,804
Alternative IV	183,813	476,156	326,445	30,514	79,143	19,298	1,829
apsulation							
Baseline	101,018	260,227	93,674	--	--	--	--
Alternative II	112,732	293,433	166,894	--	--	--	--
Alternative III	112,757	293,458	166,919	--	--	--	--
Alternative IV	112,782	293,483	166,944	--	--	--	--

Cost Element	5-unit Apartment	50-unit Apartment	Small Office Bldg.	Medium Office Bldg.	Large Office Bldg.	Small Hospital	Medium Hospital	Larg Hospi
olition								
Baseline	54,341	436,304	52,198	272,481	2,560,031	50,048	382,065	1,230
Alternative II	54,341	436,304	52,198	272,481	2,560,031	50,048	382,065	1,230
Alternative III	56,568	449,804	54,142	282,201	2,637,791	53,936	398,265	1,315
Alternative IV	56,593	449,829	54,167	282,226	2,637,815	53,961	398,290	1,315
ovation								
Baseline	28,487	187,867	29,074	160,235	1,278,912	1,122	3,175	6
Alternative II	28,487	187,867	29,074	160,235	1,278,912	1,122	3,175	6
Alternative III	30,714	201,367	31,018	169,955	1,456,672	5,010	19,375	25
Alternative IV	30,739	201,392	31,043	169,980	1,456,697	5,035	19,400	25
apsulation								
Baseline	--	--	17,228	84,405	672,322	--	--	-
Alternative II	--	--	19,222	94,175	750,132	--	--	-
Alternative III	--	--	19,247	94,200	750,157	--	--	-
Alternative IV	--	--	19,272	94,225	750,182	--	--	-

TABLE 2. COSTS OF REGULATORY ALTERNATIVES FOR DEMOLITION AND RENOVATION MODELS (Continued)

Cost Element	Single Unit Dwelling A	Single Unit Dwelling B	Single Unit Dwelling C	Small Power Plant	Medium Power Plant	Small Industrial Boiler	Medium Industrial Boiler	Small Refinery	Medium Refinery	Cruise Ship	Cargo Ship
Demolition											
Baseline	3,438	4,312	16,114	25,657	407,830	8,533	51,637	2,783,720	11,303,293	--	
Alternative II	3,438	4,312	16,114	25,657	407,830	8,533	51,637	2,783,720	11,303,293	--	
Alternative III	3,785	4,659	16,461	29,011	455,053	8,702	52,069	3,102,050	12,533,089	--	
Alternative IV	3,810	4,684	16,486	29,036	455,078	8,727	52,094	3,102,075	12,533,114	--	
Renovation											
Baseline	640	948	5,483	1,208	27,646	5,204	31,839	3,800	3,800		--
Alternative II	640	948	5,483	1,208	27,646	5,204	31,839	3,800	3,800		--
Alternative III	987	1,295	5,830	1,617	32,000	5,373	32,271	7,850	7,850		--
Alternative IV	1,012	1,320	5,855	1,642	32,025	5,398	32,296	7,875	7,875		--
Encapsulation											
Baseline	--	--	--	--	--	--	--	--	--	--	--
Alternative II	--	--	--	--	--	--	--	--	--	--	--
Alternative III	--	--	--	--	--	--	--	--	--	--	--
Alternative IV	--	--	--	--	--	--	--	--	--	--	--